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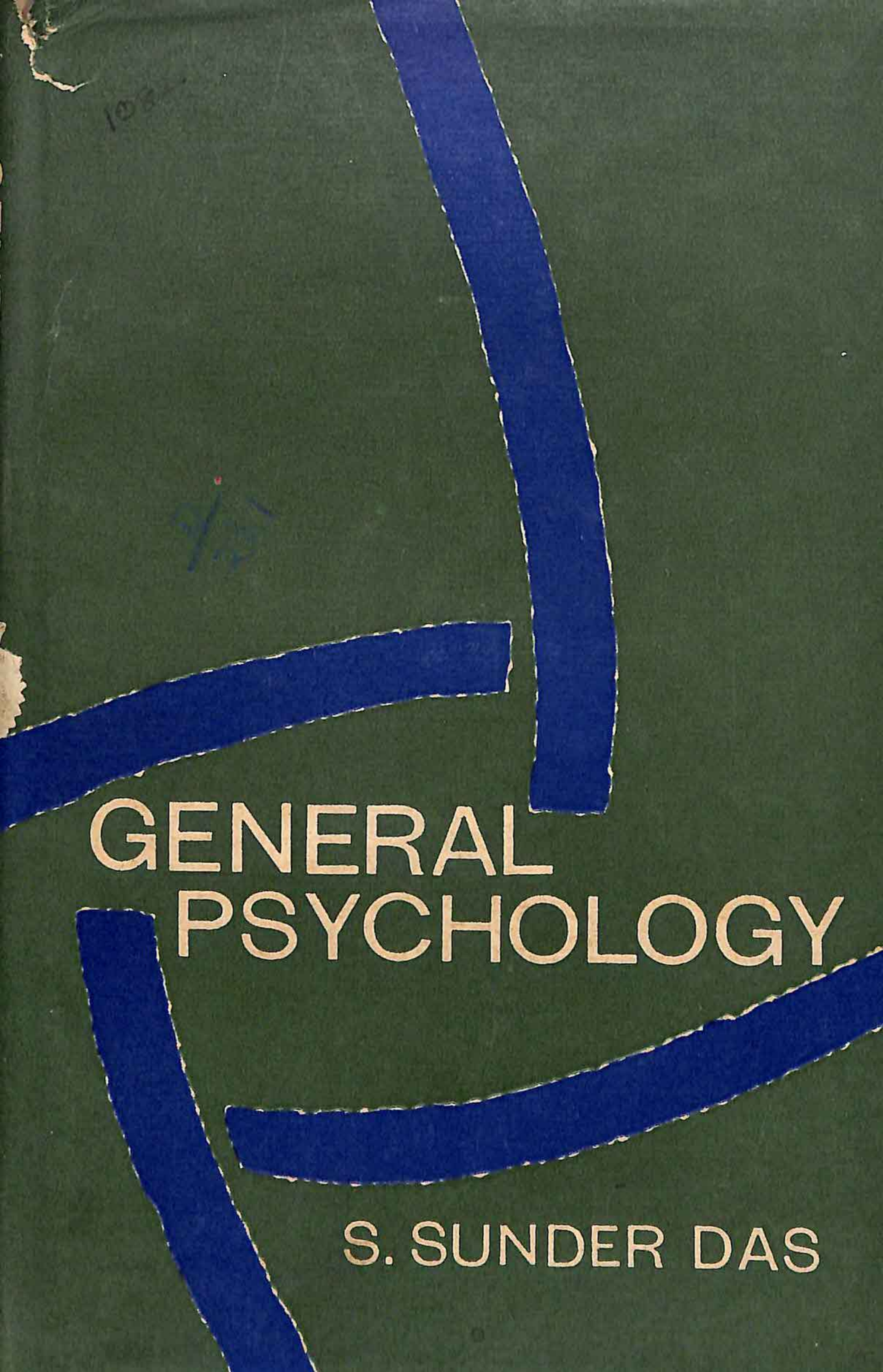

GENERAL PSYCHOLOGY

S. SUNDER DAS

THE BOOK

This new textbook of General Psychology will be widely welcomed both by teachers and students. It presents the subject as an independent experimental science and not as a mere offshoot of philosophy. Psychological concepts and problems as well as modern methods of experimentation and even recent research findings are presented in a manner understandable to a student just entering this field of study.

After presenting the basic background of physiology and evolution and animal behaviour, Dr. Sunder Das deals with the processes underlying sensation, perception, memory, intelligence, thinking, emotions, conflict, frustration, stress and mental illness. This is rounded off by chapters surveying various schools of psychology and summing up the work. A special feature is the chapter introducing the beginner to statistical methods useful in dealing with psychological data. Using only the basic minimum of theory, basic statistical methods are described and illustrated by worked examples so that a persevering student will not find it difficult to follow the reasoning and to adopt these methods himself when the time comes.

Dr. Sunder Das has provided a carefully compiled bibliography which will guide students and other interested readers to further worthwhile reading on topics of special interest to them.

THE AUTHOR

Dr. Sunder Das (b. 1924) secured his B.Sc. degree in 1945 from Travancore University. He later continued his studies in London University securing his B.Sc. (Honours) and Ph.D. in Psychology in 1959 and 1962.

Dr. Das started his career as a Chemist in a pharmaceutical concern. Later he worked as a statistical and establishment assistant for the Indian Coffee Board and spent some time, before going to London, in Ceylon and Ethiopia as a teacher of science. He now holds an appointment in the Willingdon Hospital, Delhi.

Rs. 10.50

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GENERAL PSYCHOLOGY

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GENERAL PSYCHOLOGY

S. SUNDER DAS
B.Sc., B.Sc. (Hons.), Ph.D. (Lond.)

STATE INSTITUTE OF EDUCATION * BANIPUR

S. C. E. R. T., West Bengal
Library
25/3, B. C. Road

ASIA PUBLISHING HOUSE
BOMBAY · CALCUTTA · NEW DELHI · MADRAS
LUCKNOW · LONDON · NEW YORK

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[illegible]
[illegible] 9.01.2009
[illegible] 13820

PRINTED IN INDIA
BY G. G. PATHARE AT THE POPULAR PRESS (BOM.) PRIVATE
LTD. 35C, TARDEO ROAD, BOMBAY 7, AND PUBLISHED BY
P. S. JAYASINGHE, ASIA PUBLISHING HOUSE, BOMBAY 1.

To
My Wife and My Parents

Foreword

THE inclusion of psychology in the curriculum of studies by many Indian Universities progressively within the past fifty years and the attendant research interest evinced by scholars working in this field have encouraged a few Indian Psychologists to write text books on General Psychology. This has been a healthy sign of the growing importance of the subject in this country although the number of such writers has been few and far between.

No writer need be apologetic in bringing out a new text book on General Psychology, whoever it is that writes it, whether in India or elsewhere. Particularly in India text books on General Psychology are called for in greater numbers.

Here is a subject which is steadily growing apace and which has a self acceleration of its own development. Besides, it also emerges with newer and newer concepts, as time progresses, both as regards the understanding of basic human nature and the insights that are to be gained in the more complex aspects of human behaviour. This is largely because of the impact which this science receives from the increasingly progressive activities of man in other fields such as the biological and social. New discoveries in one region immediately throw light on neighbouring areas with the result that more and more facts are integrated. To give an account therefore of the recent developments in contemporary psychology supported by experimental details and to view the subject as an objective observational discipline must doubtless be an exhilarating and rewarding experience for any writer, especially so when the quest undertaken is for a thorough reconsideration and rediscovery of the individual.

A fresh writer on a text book of General Psychology has always to surpass a new standard of excellence. Contrasted with the other texts on the market, he has to present his materials in a more integrated and updated manner which at the same time is graceful and satisfying to the reader.

A multitude of niggling little problems are likely to beset the brains of a writer when he has to consider the coverage of the material, the way in which the topics are to be assembled and the number of illustrations which are to go in. The book stands up well in that its coverage extends to a closer and more detailed account of a limited number of topics rather than leaning on the side of prolixity. That the book is not fully comprehensive is truly a blessing rather than a fault. There are books in which the photographs and art work are fortuitously collected which have neither relevance to the text nor do they illustrate the points that are made out. In contrast to such texts, this book has the unusual distinction of eschewing full page or half page photographs. The only illustrations added are line drawings clearly written and made intelligible to the ideas conveyed.

Text books on General Psychology vary in the extent to which they fulfil their function. Some in their endeavour to make the material interesting, attractive and meaningful include precious little research data that they perilously come near to the level of a Sunday supplement series on psychology. Others veer to the opposite extreme in their attempt to justify psychological concepts, theories and principles by offering an endless and tiresome series of experimental data. Some texts take a molar and others take a molecular approach in the conviction that the one or the other would exclusively be the proper standpoint. It is a pleasure to note that the author has avoided either extreme and has struck a reasonably fair balance. Not the least of the merits of the book is Dr. Sunder Das's ability to present research findings in a manner suited to the background of the reader.

The principles and basic processes underlying sensation, perception, thinking, intelligence, learning, conditioning, forgetting, motivation, memory, conflict, frustration, stress and behaviour pathology have been analysed at length in the respective chapters dealing with them. The author is at his best when dealing with learning, motivation and memory. The last particularly has been his chosen field for his doctoral work and most of the points offered here are of relatively recent vintage and are distinctive of his experimental work. The author has done well in including a chapter on the application of the statistical methods in dealing with psychological data which can be understood by the beginning student without tears. The neurological picture which is closest to that of psychology is brought in wherever necessary without raising it to the position of a guiding star. Psychological phenomena at the sub-human level have been brought in as comparative data for the clarification of the important aspects of human nature and behaviour. Contributions coming from social, anthropological and other special fields have been included in an appropriate way. The names of investigators and dates are given to indicate the historical development of the science.

I consider it a privilege to have been asked to write this introductory note by a fellow worker in the field of psychology. Dr. Sunder Das did his post-graduate study and doctoral research in London and has had the good fortune to work under noted British psychologists like Emeritus Professor Dr. C. A. Mace, Professor A. Summerfield and Dr. John Brown. In addition, Dr. Das's knowledge and experience have extended to clinical psychology and child guidance work. He is currently engaged as a clinical psychologist in the department of psychiatry at the Willingdon Hospital, Delhi.

The striking features of his book are the remarkable clarity of exposition and explicitness in defining the concepts. Dr. Das has achieved well the task which he had set out to accomplish. Certainly his book will be enjoyed and appreciated by introductory students and even advanced students and by psychologists.

Sri Venkateswara University
Tirupati (A.P.)

S. PARTHASARATHY
Professor and Head of the
Dept. of Psychology

29 *August* 1963.

Preface

THE reader is about to enter the fascinating world of a new science in which horizons are still expanding. Time was when psychology existed as a small and somewhat insignificant part of the study of formal philosophy. Today it is a special field and those interested in it are trying hard to systematize its innumerable findings into some kind of classification. Psychology can no longer be explained as "the study of the mind" partly because the mind itself has not been satisfactorily defined and also because it is now realized that a person reacts to the environment with his whole being. The word "behaviour" covers most of the activities of men and therefore the present trend is to describe psychology as the "study of behaviour".

Thus it would be obvious even to the most casual thinker that the anatomy of the human body and its physiology are of prime importance in the better understanding of behaviour. In the study of the brain and the nervous system, a knowledge of chemistry and physics would be useful if one likes to understand fully the changes which occur during the conduction of nerve impulses. All this goes to explain why psychology is such a composite discipline covering vast fields and why it is necessary to include a chapter on physiology in most text books of psychology. The theory of evolution has also had an important bearing on this subject. If the human being is a further development of the lower animal, it becomes obvious that animals like the dog and the ape must show less complicated behaviour because of their less developed nervous systems. Therefore, studies of the behaviour of animals would be the step towards the understanding of the behaviour of human beings. This brief survey of the scope of psychology would have helped the reader to realize the vastness of the subject.

No text book of psychology can expect to cover all the different aspects of the subject and to do full justice to every one of them. This book, therefore, seeks to provide the necessary groundwork upon which the student, embarking on this study for the first time, can build. The central problems of psychology are Perception, Intelligence, Learning and Memory; these have been covered fairly well here and latest experimental findings have been incorporated wherever possible. In the chapter on Physiology, the author has endeavoured to provide the necessary knowledge in a simple way and at the same time he has introduced certain modern ways of thinking.

Students who feel some trepidation towards statistics have the author's sympathy. Nevertheless, the study of statistics is important because it makes it possible to present psychological findings in an intelligible fashion. The chapter devoted to this topic in the text book makes an important deviation from the conventional approach in that theorization has been confined to the basic minimum; the well-known statistical methods described here are illustrated by worked examples and the persevering student should not find it difficult to follow the logic of these.

It is a common experience of most students of Psychology that "ingestion" does not immediately follow the reading of the subject as happens in the physiological process in which nutriments begin to be absorbed immediately following the intake of food. Therefore, the student would be well advised to come back to his reading again and again—in short, he has to practise what he is about to learn in the chapter on Memory. As the understanding of the subject develops, there would unfold a fascinating panorama which may encourage the student to take to wider reading. The bibliography at the end gives adequate guidance on the choice of reading material.

Well, here's to many hours of reading enjoyment.

S. Sunder Das

Acknowledgements

MY thanks are due to Major S. Parthasarathy, Professor of Psychology, Sri Venkateswara University, Tirupati, Andhra Pradesh, for having consented to write the Foreword to this book.

S. Sunder Das

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CHAPTER ONE

Physiology

THE NERVOUS SYSTEM

To achieve the perfect coordination among the parts evident in the functioning of the human body, it is essential to have a well-developed communication system linking each part with every other. This important role is performed by the nervous system which can be classified into two broad divisions, the central nervous system (C.N.S.) consisting of the brain and the spinal cord, and the peripheral nervous system (P.N.S.) made up of the cranial, spinal and autonomic nerves. The peripheral nerves connect the central nervous system to the sense organs and the muscles.

The nervous system is built up of nerve cells known as neurons and also contains supporting tissue and blood vessels. Neurons have two functions to perform; some of them carry messages from the sense organs to the C.N.S. and are known as sensory neurons or receptors because they receive impressions from the outside world through the sense organs. Others transmit messages from the centre to the muscles, and these are the motor neurons or effectors. The messages any neuron carries are electrical impulses.

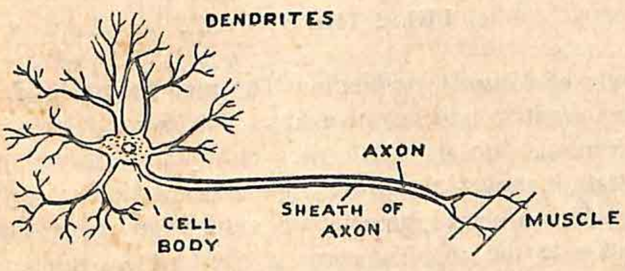
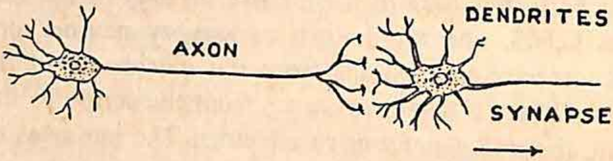


FIG. 1 A NEURON HIGHLY MAGNIFIED

Each neuron is an elongated nerve cell sometimes several feet in length. The cell body itself contains a nucleus inside an expanded portion known as the perikaryon. Two kinds of processes called the axons and dendrites arise from the perikaryon and lead to different directions. Usually each neuron has only one axon which is smooth and almost of uniform thickness throughout its length; each axon has several knobs called boutons at its end and these make contact with dendrites of other neurons. The dendrites appear to have a thorny surface and branch and rebranch several times. The ramifying network of neurons has one peculiarity in that there is no anatomical connection between one neuron and another. The axon of one neuron remains in close proximity to another cluster of dendrites and sometimes amaeoboid growths may bring these two elements closer together. This kind of neural connection by contact only is known as the synapse. Each axon by branching at its end may establish contact with dendrites from several cells and is thus able to transmit impulses to one other cell or to several others at the same time. Neural elements are one way channels in that the axons always conduct impulses *away* from the perikaryon and the dendrites *towards* it. Further, neurons do not remain as single threads but exist as "bundles" with a good system of insulation separating one fibre from its fellow as in a composite electric cable.



THE DIRECTION OF NEURAL IMPULSES

FIG. 2 THE SYNAPSE

The Nature of Neural Conduction: The metabolism inside the nerve cell produces positive and negative ions. The delicate balance between these two kinds of ions is upset when stimulation occurs and a wave of depolarization moves along the fibre. The particular surface of the fibre inside which a neural impulse is passing at any given time, is negative in relation to the adjacent areas of the surface. Immediately after a neural impulse has passed through, the fibre is said to be in a refractory phase because it cannot conduct another impulse till it has recovered. It takes 2/1000th of a second for it to recover partly and about 12/1000th of a second for it to be fully ready to transmit another neural current. The maximum speed of neural conduction particularly in the larger fibres has been estimated to be 1,000 metres per sec. In the smaller fibres the speed of conduction might be considerably less and in lower animals it would be much less than that in human beings.

A peculiar feature of neural conduction is that the potential of a neural current is always the same whatever be the intensity of stimulus which initiates a current. When the stimulus is strong enough to initiate a neural current, the impulse occurs with the fullest intensity that the particular fibre is capable of. This is known as the "All-or-none Law". The difference between a strong and a weak stimulus depends on the number of impulses which are initiated within a given time and the number of fibres which take part in the conduction. A stronger stimulus obviously initiates more impulses per second in a larger number of fibres.

The Reflex Action and the Reflex Arc: A neuron from a sense organ after making synaptic connection with other neurons forms part of a neural chain which leads into the spinal cord. An internuncial nerve fibre connects the sensory nerve with a motor nerve, also rising from the same area in the spinal cord. The motor nerve leads to a muscle. The area in the spinal cord where the sensory nerve leads in and from where the motor nerve leads out, is known as the "lower" centre the function of which is to coordinate the working of the muscles. The spinal cord contains many such "lower," centres each of which is connected to an appropriate "higher centre" in the brain. The higher centres can operate the muscles only through the lower centres and the function of the former is to coordinate the working of the latter. When the higher centres take part in muscular movement we become aware of it. But there are some exceptional cases in which muscular action takes place without any volition and sometimes even without concomitant awareness. Such a phenomenon is called a reflex action, some common examples of which are sneezing, coughing and the reflex wink of the eyelids. The neural structures which initiate a reflex action consist of a closed chain leading from the receptors to the spinal cord and through the effectors into the muscles. Thus a receptor impulse automatically initiates a motor impulse which leads to the appropriate movement of the muscle concerned. Reflex actions can be incredibly fast as is seen from the reflex wink of the eyelids which takes only .05 second and the reflex knee-jerk which takes only .03 seconds. Another characteristic of the reflex action is that it acts with full efficiency all the time.

THE BRAIN

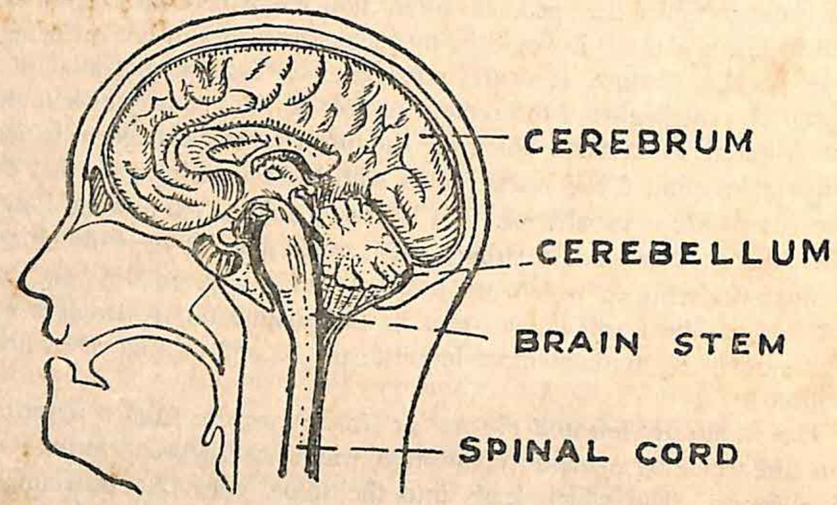


FIG. 3 LOCATION OF THE BRAIN INSIDE THE CRANIUM

As we ascend the phylogenetic scale, animals are found to have progressively complicated nervous structures. Invertebrates like the jelly fish do not possess a brain, which fact limits their behaviour to the simplest of movements. At a slightly higher stage of evolution, animals possess a number of nerve centres known as ganglia which permit a greater variety of behaviour. Still higher forms of life have fewer ganglia and in addition have rudimentary brains. An animal with a brain has to be a vertebrate because the brain as also the spinal cord have to be protected by a hard covering. In the primates especially in man the brain is a highly specialized organ, the functions and operations of which are still not completely known. The possession of a well-developed brain helps man to avoid stereotypy in behaviour and enables him to learn many things with the application of insight.

The human brain is an upward extension of the spinal cord. Regional names are used to describe the different parts of the brain. The forebrain thus consists of the two cerebral hemispheres and an unpaired central part known as the diencephalon.

The cerebral hemispheres (the right and left halves) are similar in shape and size. The right hemisphere controls the left half of the body and vice versa; it is not quite clear as to why there is this crossed relationship. One of the hemispheres—usually the left one in all right-

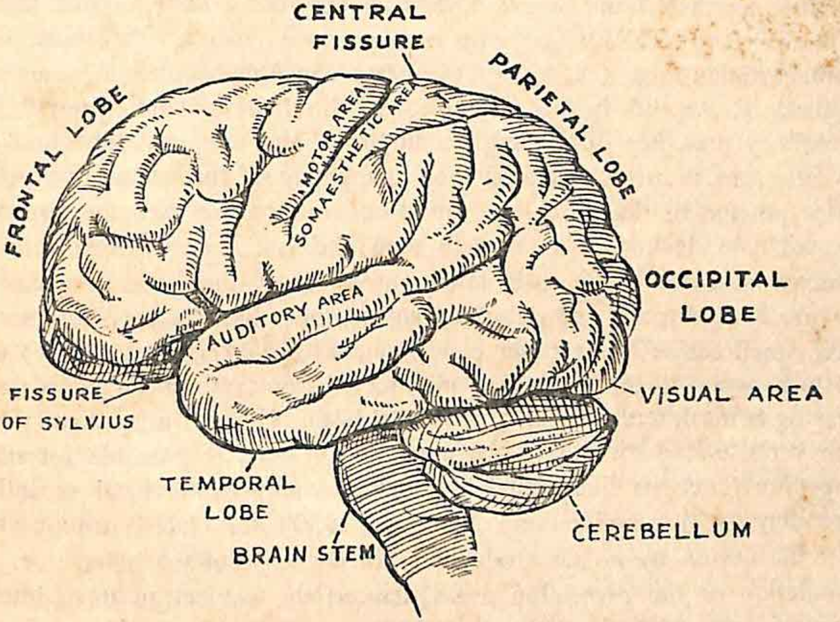


FIG. 4 DIFFERENT AREAS OF THE BRAIN

handed people—is the dominant hemisphere because it causes the corresponding side of the body to be more facile than the other. The surface of the cerebrum consists of cell bodies and dendrites collected in thin layers of grey matter known as the cortex. It has been estimated that there are about 10,000 million neurons in the cerebral cortex. The surface of the brain shows a convoluted appearance which is obviously a device to increase the surface area of the brain. These convolutions are also known as gyri. In addition, there are also deep fissures which extend a little into the brain without actually dividing it into separate parts. For purposes of study however, we speak of the divisions of the cerebrum into several lobes the boundaries of which are formed by the particular fissures. The lobe just under the forehead is the frontal lobe behind which is the central fissure (or Rolandic fissure). Then comes the parietal lobe which is separated from the occipital lobe by another fissure. Below the frontal lobe and a little to the back is the temporal lobe situated behind the fissure of Sylvius.

Early experimenters discovered that particular areas of the brain have specific functions to perform which fact is known as the principle of cortical localization. An area immediately in front of the Rolandic fissure on the frontal lobe is known as the motor area because stimulations there produce movements of various parts of the body. The somaesthetic area, the part of the brain concerned with cutaneous and muscle senses, lies in the parietal lobe behind the Rolandic fissure. The auditory area lies in the upper margin of the temporal lobe and the visual area is in the occipital lobe at the rear of the brain. The posterior portion of the third left frontal convolution, an area the size of a small coin, is known as Broca's area and is the part responsible for motor speech. The post-Rolandic area serves the general senses of warmth, cold touch and pain; and an area near the olfactory bulb serves the smell sense. Many other experimenters like Wermicke (1874) and Hinshelwood (1900) made a number of observations on people suffering from different types of localized brain injury as a result of which they postulated that there are many more areas responsible for other specific functions like visual memory as apart from visual sensation, reading, writing and talking. Penfield (1950) stimulated various areas in the cortex by an electrode and noted the resultant behaviour; stimulation of the projection areas, caused the subject to have intense experiences relating to the particular sense stimulated. However, the stimulation of some parts of the pre-frontal areas and the temporal lobes caused the subjects to re-live vividly some of their past experiences. Olds and Milner (1954) implanted an electrode in some sub-cortical areas of a rat's brain and left it there till the animal recovered from the operation. An electrical current passed through this region was found to give some kind of pleasurable sensation to the animal. When the rat was taught to press a bar to switch on the electric current, it continued to do so with all signs of enjoyment. Stimulation of some other areas of the sub-cortical brain caused irritations.

Another method of mapping out the functions of various areas of the brain is by extirpation (removal or destruction) of specific parts of it and observing what effect it would have on the animal. Obviously, this method cannot be used with human beings. In a human patient who shows loss of or disturbance of a particular function and subsequently dies, an autopsy can be performed with a view to ascertaining whether the disturbance of function was caused by a localized brain injury. Efficient means of staining neural tissue has made it possible to trace nerve fibres from specific sense organs to particular centres in the spinal cord and thence to the corresponding higher centres in the cortex.

Karl Lashley (1920, 1922, 1929) conducted a number of experiments on the effects of progressive ablation of the brain in various animals and concluded that the loss of function consequent on increasing loss of brain did not depend so much on the area of the injury as on the amount of brain matter removed. This concept is known as the mass action of the brain. Lashley also suggested that various parts of the brain may be said to be equipotential in that one part of the brain could easily take over the functions of another injured part. This also implies that there may be a limiting minimum quantity of brain necessary, below which all functions may be disturbed. Most of Lashley's earlier work was done on the albino rat; results of later work on chimpanzees made him modify his original theories in some ways. He granted the existence of certain amount of localization of brain function particularly in the primates, and provided the primary projection areas in the cortex are intact, the principle of mass action and equipotentiality would apply to the rest of the brain concerned with diffuse functions.

The Diencephalon: This is the name given to the thalamic region just above the midbrain; it consists mainly of the thalamic bodies the function of which is to act as a relay station for sensory impulses passing upwards to particular receptor areas of the cortex. The diencephalon also contains the pituitary gland which is concerned with the promotion of cell growth in the body and the regulation of the functions of the various hormones.

The Hind-Brain: This consists of the pons, the cerebellum and the medulla oblongata. The cerebellum is primarily concerned with coordination of muscle activities and localized areas on it have specially intimate relationships with different parts of the body.

THE EYE

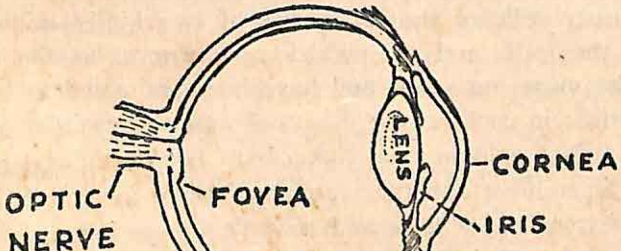


FIG. 5 THE EYE

The analogy about the eye and the camera cannot be pushed too far because unlike the camera, the eye itself cannot make a person see. The actual visual perception is the function of the occipital area of the cortex.

The eyeball is kept in position by three pairs of extrinsic muscles. The two eyes work as a team, sometimes making parallel movements known as conjugate movements as in following a distant moving object, and at other times making opposing movements called convergence as when fixating on a comparatively near object. The idea of such a movement is to allow the image of the object to fall on an area of the retina which gives the clearest vision, the fovea centralis.

Each eye is roughly spherical in shape with a slightly bulged transparent lens known as the cornea in front. Behind the cornea is an adjustable membrane with a hole in the middle, the iris, the aperture of which known as the pupil becomes smaller or larger depending on the intensity of light falling on it. Bright light constricts the pupil whereas in dim light it opens out to the fullest extent. Immediately behind the iris is another lens held in position by ciliary muscles which also help to change the convexity of the lens and thus facilitate focussing. The inside of the eye is filled with a transparent fluid through which light travels and falls on a sensitive membrane called the retina at the back of the eye. There is a small depression at one point of the retina straight back from the pupil, known as the fovea centralis, the area of clearest vision. That is why the eyeballs rotate to allow the image to fall on the fovea whenever an object has to be examined closely. There is another spot not very far from the fovea where the nerve fibres from the eye join the optic nerve and is therefore not sensitive to light; this is the blind spot.

The sensory cells of the retina are of two kinds—elongated ones known as the rods, and short thick ones known as the cones. The rods are the more numerous and have been estimated to be 125 million in number in each retina; these cells are responsible for the light-dark sense. The cones in each retina have been estimated to be about 10 million in number and these are responsible for colour vision. The fovea consists of cones only and towards the periphery of the retina the number of rods increases till at the fringes there are rods only. The eyes are able to adapt quickly to the darkness because a substance known as visual purple (rhodopsin), present only in the rods and which gets bleached in bright light, is restored in dim light. Another piece of evidence in support of the theory that dark vision is confined only to the rods is the fact that most nocturnal animals like the bat possess very few cones but a large number of rods in their retinae. This theory of rod and cone vision known as the Duplex Theory is due to Von Kries (1929).

When visual purple, the most essential substance for the efficient functioning of the rods is lacking, dark adaptation is lost and leads to night blindness which condition can sometimes be remedied by increasing the intake of vitamin A known to be rich in rhodopsin. Conversely, people with normal vision if subjected for long periods to a diet deficient in vitamin A would have great difficulty of seeing in dim light.

Mechanism of Colour Vision: The differences in colour are produced by differing wavelengths, the red light having the longest wavelength (760/1,000,000 millimetre) and the violet light having the shortest wavelength (390/1,000,000 millimetre) respectively. The other colours orange, yellow, green, blue and indigo have interim wavelengths. There are many other wavelengths in the spectrum either longer than red or shorter than violet but these do not give the sensation of colour; they affect the body in other ways as in the sensation of warmth caused by the long wavelength infra-red rays.

Light falling on the eyes causes three different kinds of sensation delineated as brilliance, hue and saturation. Brilliance depends on the intensity of the stimulus and is measured along a dark-light dimension. Hue is a property due to the particular wavelength of the light and when the stimulus light consists of one particular wavelength only, the colour is said to be saturated. Saturation does not depend on the appearance of the colour; that is whether or not it is bright. It depends on whether there is only one wavelength or a mixture of many wavelengths. Two wavelengths (coloured lights) are said to be complementary when on mixing they produce either white or grey. The following pairs of colours are complementary:

Blue and Yellow   Red and Bluish Green   Green and Purple

Theories of Colour Vision: The first well-formulated theory of colour vision was outlined by Young and later elaborated by Helmholtz. According to this theory there are different kinds of receptors in the eye separate stimulation of each of which gives the sensation of red, green and blue respectively. Combined stimulation of these three

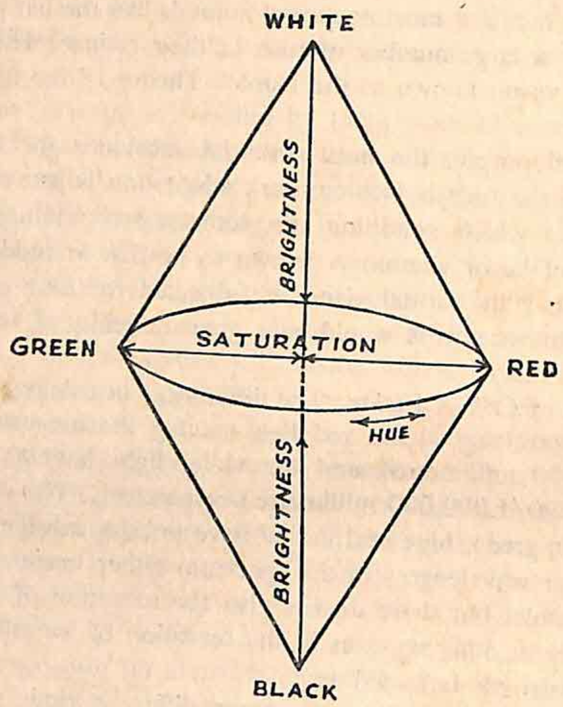


FIG. 6 A THREE-DIMENSIONAL COLOUR CHART

kinds of receptors in varying degrees of intensity produces all the different colours. Corresponding to the three types of specialized receptors in the eye, there are separate areas in the visual cortex and the mixing of colours may be a cortical function. Though this theory is admirable for its simplicity, it cannot explain certain observed facts especially related to colour-blindness. There occur two different forms of colour-blindness. Some people lose the ability to perceive red colour and others lose the ability to perceive green colour. People with the former type of colour-blindness are known as protanopes and those with the latter as deuteranopes. Total absence of colour vision is very rare, even though there are some instances in which the ability to perceive red and green has been lost together. In such cases, it was still possible to perceive yellow which is midway between the colour range red-green. If the Young-Helmholtz Theory were correct, individuals having red-green blindness should perceive only blue and not yellow because the receptors responsible for the sensation of both red and green colour should be defective resulting in the loss of yellow colour also.

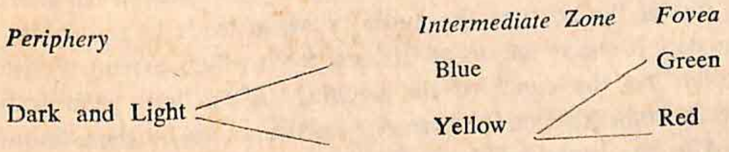
That the retina is not uniformly colour-sensitive is shown by the fact that while the fovea of a normal person gives all the colours, the periphery of the retina gives only the sensation of light and dark. Just inside the periphery blue and yellow are perceived, the sensations of red and green appearing only very close to the fovea. This fact would seem to suggest that there might be other kinds of receptors responsible for the perception of yellow.

The experimental findings outlined above led Hering to formulate another theory according to which the three basic substances in the retina are each capable of two processes—that of breaking down (known as anabolism) and that of building up (known as catabolism). Anabolism produces black, blue and green while catabolism produces the sensation of white, yellow and red. Perhaps a chart would make this clear.

Process	*Substance* 1	*Substance* 2	*Substance* 3
Anabolism	Black	Blue	Green
Catabolism	White	Yellow	Red

This theory accounts for the presence of different colour zones and also for the different types of colour-blindness.

Another theory giving an evolutionary aspect to colour perception is the Ladd-Franklin Theory according to which the primitive aspect of colour vision is the perception of black and white or the differentiation between light and dark found in the periphery of the retina where the receptors are just photo-sensitive. In the region just inside the periphery, the light sensitive material is capable of differentiating between blue and yellow. And still nearer the fovea, the colour blue persists but the yellow substance splits again into green and red.



This suggests that green-red blindness might be due to the absence of the last stage of differentiation in as much as the yellow colour is retained instead of red-green. This theory also explains the facts about the presence of different colour zones in the retina.

THE EAR

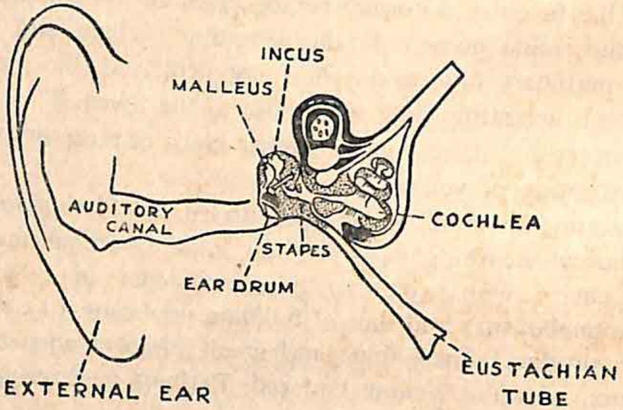


FIG. 7 THE EAR

The external ear consisting of a fan-shaped piece of cartilagenous material has two functions to perform—that of directing the sound waves into the auditory canal and of helping to assess the direction from which a sound originates. The auditory canal leads into the ear and ends in the tympanic membrane, usually known as the ear-drum which is thrown into vibration whenever sound waves strike it. Its movements are transmitted by a system of three bones known as the ossicles, to the inner ear. The ossicles consist of the malleus, incus and stapes (known also as hammer, anvil and stirrup respectively). The lower end of the stirrup transmits the vibrations to the inner ear through a small aperture known as the oval window. The inner ear, filled with a fluid and curved up like a snail's shell is known as the cochlea which is divided into two longitudinal divisions by the basilar membrane. From the top of the cochlea the auditory nerve leads to the brain. On the basilar membrane is the organ of corti from which extend thousands of hair cells into the canal of the cochlea. These hair cells activate receptor cells embedded in the organ of corti and finally these impulses are carried to the brain by the auditory nerve.

Though the anatomy of the ear is known, the exact mode of functioning of the basilar membrane is still subject to theorizing. This is due to the fact that the mechanism of hearing is far from simple and also because the range of audible frequencies is enormous, varying from 20 to 20,000 cycles per second.

Theories of Audition: (1) *The Resonance Theory*: Helmholtz (1863, 1870) formulated the resonance theory which is also known as the place theory because it assigns the function of handling specific frequencies to different parts of the basilar membrane. The narrow end of the basilar membrane nearest the oval window resonates to the highest frequencies and the comparatively broad portion of the curled up end of the membrane vibrates to the lowest frequencies. The intermediate frequencies are handled by the middle portions. This theory of audition is based on the mechanism of sound production in a stringed instrument, the shortest length of string producing the highest note and vice versa. The dimension of loudness is handled in this theory by postulating that a soft sound transmits less energy to the vibrations which activate only a few nerve cells, whereas a loud sound activates a larger number of them by giving greater energy to the vibrations.

(2) *The Telephone Theory*: Rutherford's (1886) telephone theory postulates that the frequency of the external sound is transmitted by the nerve fibres to the brain and also that loudness depends on the number of nerve cells stimulated. Thus each part of the basilar membrane can handle all the auditory frequencies and in this sense it is not a place theory. Though this theory is admirable on account of its simplicity it fails to explain how the highest audible frequency (20,000 cycles per second) can be transmitted by the nerve cells because it is now known that each nerve fibre is capable of carrying a maximum of only 1,000 impulses per second.

(3) *The Volley Theory*: The volley theory of Wever (1949) is an ingenious one which seeks to combine the place theory of Helmholtz with the Frequency Theory of Rutherford. Wever envisaged the nerve cells as firing in volleys, a certain number of fibres taking part during each vibration.

TASTE

The tongue, which is the chief organ for the sense of taste, is covered with papillae each of which contains one or two taste buds. These taste buds in turn contain innumerable tiny hairs which activate nerve endings under them. A patch of area at the front end of the tongue has been found to be devoid of papillae and therefore it cannot take part in the sensation of taste.

Four different tastes have been isolated; these are the sweet, sour, saltish and bitter. The perception of each kind of taste is localized to a large extent because a definite area on the surface of the tongue specializes in detecting one kind of taste. For instance, the bitter taste is found to be mostly perceived by the back area of the tongue, the sweet from the front end, the saltish more or less widespread over the whole area and the sour on the edges. This should not be taken to mean that localization is carried to the point of exclusiveness because all areas of the tongue can detect all the four tastes to a greater or lesser extent. The mapping of these different areas of the tongue which respond to particular tastes, is done with the help of what is known as the Haynes gustometer. This consists of a U-tube with a hole under the middle of the U through which the required liquid could wash over a small area of the tongue. The advantage of this method is that very small areas of the tongue can be gone over and accurate results obtained.

The chemistry of the substances giving differing tastes is a very elusive matter but the sources of some of these are believed to have been isolated. For instance, the sour taste found in acids is thought to be due to the free hydrogen ions dissociated in solution. The saltish taste of some substances is believed to be due to the metallic cation present in them; the bitter and sweet tastes have not been satisfactorily traced to any single chemical. This may have been partly due to the fact that many dissimilar substances stimulate these senses as for example glucose, saccharine and nitro-benzene causing a sweet taste.

When any substance is kept in the mouth for a long time, the sensation of taste becomes less intense and may even disappear after some time. This phenomenon known as negative adaptation, can be demonstrated with all the other senses too. The extent of negative adaptation differs with each taste, the saltish and sour being easiest to adapt, the bitter taste not getting adapted so easily.

SMELL

Though the nose is the organ of smell, the exact location at which detection of smell takes place is tucked away deep inside the nasal passages. At the top of these passages, there are two small patches of yellowish membrane called the olfactory epithelium in which the receptor cells are embedded. The hairlike tips of the receptors project into the mucous covering the membrane. The olfactory membrane is situated so deep in the nasal cavity that odoriferous air reaches it only as eddy currents. When we want to sample a smell, we sniff and this enables stronger air currents to flow over the epithelium. Any material must be capable of being transformed into a vapour before its smell can be apprehended; the greater the volatility of a substance, the greater its capacity to affect the small receptors even when it is present in infinitesimally small quantities. This account makes it clear that we cannot smell a non-volatile liquid.

Though all smells can be broadly classified as agreeable and unpleasant, a workable system of smell classification is due to Henning (1915, 1916, 1924) who suggested the model of a prism at the corners of which basic odours can be represented. The basic smells in the Henning prism are:

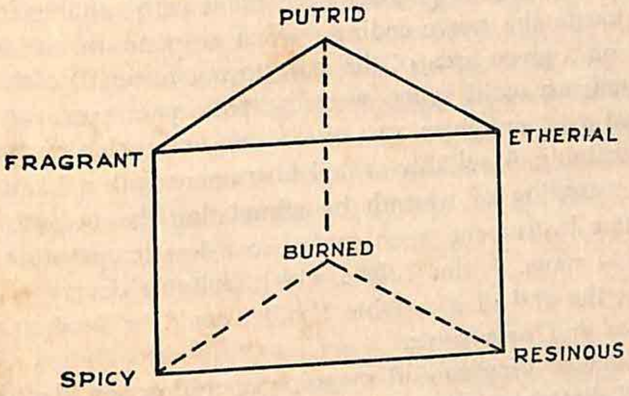


FIG. 8. HENNING PRISM

Fragrant — like oil of jasmine
Ethereal — like oil of lemon
Resinous — like turpentine
Spicy — like cinnamon
Putrid — like hydrogen sulphide
Burned — like oil of tar

Recently, it has been realized that the senses of smell and taste are inextricably related; the taste of a substance is not entirely determined by the papillae on the surface of the tongue but is reinforced also by the odour emanating from it. This is the reason why a heavy head-cold prevents the full enjoyment of food, when a piece of apple may appear tasteless. This inter-relationship of smell and taste can easily be demonstrated by sipping lemon juice with and without the nostrils being closed. The ethereal smell of lemon juice gives a distinctive flavour to the drink. This may be the reason why it is customary to speak of flavour rather than of taste alone when speaking of food.

THE SKIN SENSES

The sense of touch is not one sense as had been imagined for a long time. Blix, Goldsheider and Donaldson independently carried out investigations on the skin senses and found that there are four different ones—the senses of cold, warmth, pressure and pain. Von Freys amassed a large volume of experimental data to prove the existence of these skin senses and the way they act. His method was to map out small areas of the skin and to go over each point with suitable instruments, trying to locate the nerve-endings which respond to various stimuli. All points on a given area of the skin do not respond to the same stimulus. There are cold spots, warmth spots, pain spots and pressure spots dotted over any given area of the skin and which respond to their respective stimuli. A suitably-heated instrument with a blunt tip would cause the sensation of warmth by stimulating the warmth receptors, and the same instrument when cooled to a low temperature could detect the cold spots. A fine bristle with a suitable degree of flexibility, mounted at the end of a suitable handle, could be used to investigate the pressure and pain spots.

As a result of very careful mapping operations on the skin, it has been found that pain spots are the most numerous, the pressure spots come next followed by the cold spots, and the least numerous are the warmth spots. The depth at which each type of receptor occurs also differs, the cold spots being found on the surface of the skin and the warmth spots only .6 millimetres below the skin surface. These locations were established by the fact that it took only .15 seconds to stimulate the cold spots while it took .18 seconds to activate the warmth spots. The stimulus threshold for each of these skin senses has also

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been found to be different, the pain spots being stimulated only by a greater intensity of stimulus.

However, localization of the various spots relating to the skin senses took a long time to establish beyond doubt not only because their microscopic dimensions made it extremely difficult to track them but also because slight variations in their positions were noticed from day to day possibly due to slight contraction or expansion of the skin. Histological investigations have revealed that there are six kinds of nerve endings present on the surface of the skin, and it is logical to think of a particular nerve-ending as being responsible for a particular skin sense. The free-branching nerve-endings are most numerous and they are believed to be predominantly responsible for pain sensations. The Kraus bulbs are thought to be responsible for the sensation of cold and the clusters of nerve-endings around the hair follicles are thought to register sensations of pressure.

One of the peculiar effects observed on stimulation of the skin is the effect of inadequate stimuli—that is the application of one kind of stimulus on a receptor meant for a different kind of stimulus. Thus when a heated needle is placed on a cold spot, it gives the sensation of cold. This is the "paradoxical cold". If cold and warmth spots are simultaneously stimulated by needles kept at room temperature a sensation of warmth known as synthetic heat, arises. The skin senses, especially those of warmth and cold, can undergo a great deal of negative adaptation; but pressure and pain spots acquire such adaptation only after a prolonged application of the requisite stimuli which very few people can stand with equanimity for any length of time.

ENDOCRINOLOGY

The endocrine glands are different from other glands in the human body in that they deliver their secretions directly into the blood stream. These glandular secretions, known as "hormones" modify the activity level of the body or particular parts of it. Some of the most important endocrine glands are described below:

(1) *The Pituitary Gland*: This gland occupies a very important position in the endocrine hierarchy not only on account of its geographical location at the base of the brain, but also because its hormones control the activity of other endocrine glands and regulate body processes like blood pressure and the intake of water. The pituitary gland

has a great influence on bodily growth, its overactivity in early childhood producing super-normal growth of muscles and bones. Its underactivity on the other hand produces midgets who are perfectly-formed human beings but of a smaller size than normal people.

(2) *The Thyroid Gland*: This gland is located at the base of the neck and in front of the windpipe. The presence of a trace of iodine in the daily intake of food is necessary for its healthy functioning, failing which the thyroid gland swells up to give the condition known as goitre. Damage to the thyroid either by disease or accident causes a sluggish condition to develop, in which the individual loses his ability to concentrate and to think connectedly. Congenital defective functioning of the thyroid gland is known to cause the development of cretinism in which condition the individual remains a misshapen dwarf with low intelligence.

(3) *The Adrenal Glands*: These are two in number and located very close to the kidneys. The cortex of each adrenal gland produces the hormone called "cortin" whereas the medulla (middle part) produces the hormone "adrenalin". This latter hormone, sometimes also referred to as "adrenin", when present even in minute quantities in the blood stream, mobilizes the bodily functions in readiness for aggressive behaviour or flight. Some of its spectacular effects are the increasing of the heart-beat, suspension of digestive activity, release of stored sugar from the liver, increase in the ability of the blood to clot and general rise in the activity level of the body. Thus it is an adjunct to the sympathetic section of the autonomous nervous system and prepares the body to cope with an emergency.

Cortin, on the other hand, is concerned with the absorption by the body of the alkali metals, and the metabolism of sugar. This hormone also has to do with the development of masculine characteristics.

(4) *The Gonads*: These are responsible for the production of the sex hormones which cause the distinctive development of the male and female characteristics respectively.

(5) *The Pancreas*: The pancreas produces two secretions one of which—the pancreatic juice is essential for digestion and passes into the intestines. The other, called "insulin", is essential for sugar metabolism. In the disease called diabetes the insulin production by the pancreas is disrupted, with consequent inability of the blood to oxidize and use up sugar. Insulin injections are, therefore, given to diabetics to remedy the inability of the body to use up sugar. An excess of in-

sulin causes a sudden drop in the blood-sugar level below a critical value, and the effects of it can be very marked. Irascibility, changes in mood and vague feelings of apprehension, usually associated with diabetes, are a result of the fluctuating sugar level in the blood.

CHAPTER TWO

Learning and Motivation

THE modern concept of behaviour is to think of it as a response to either of two types of stimuli—internal stimuli also referred to by various other names as drive, motivation and so on, and external stimuli acting via the sense organs. This particular definition also implies that the behaviour of organisms, whatever be their level in the phylogenetic scale, cannot be quite random in character. Before one can make a proper study of complex behaviour patterns, it would be necessary to break down these patterns into elements if that is possible, or to study the behaviour of organisms with rudimentary nervous systems and therefore occupying the lower rungs of phylogeny. In this process of searching for simple types of behaviour one comes across terminology which seems to refer to particular levels of behaviour and not to others. These are not really meant to be compartmentalized definitions which can always be mutually exclusive.

TROPISMS

One of the simplest types of behaviour is shown by all plants and some lower forms of animal life. This is known as Tropism usually defined as orientation in response to specific stimuli which are denoted by the prefixes attached to the word "tropism". Thus geotropism would represent the tendency for the roots of a plant to move towards the centre of the earth, hydrotropism would denote the orientation of roots towards water and heliotropism, of the orientation of the shoots and leaves towards the sun. Loeb thought that even a creature like the moth, which cannot be considered to occupy the lowest level of phylogeny, may also be guided by tropisms in its behaviour. As an example, he considered the flight of the moth towards a flame. At first the moth flies around the flame and therefore receives heat stimulation only on one side of its body. This unequal stimulation makes the moth to turn till both sides of its body receive equal amounts of heat and subsequently to fly straight into the flame. Various animals like the planaria and daphnia which normally move straight towards a light, if blinded in one eye, have been found to move in circles around a source of light so that the uninjured eye is in a position to receive constant stimulation. From all these experiments Loeb concluded that a simple oriented movement can be explained as a coordination of reflexes. He went a step further and drew two more general conclusions, that all oriented movements are tropisms and that all behaviour consists of tropisms. Subsequent research by careful experimenters has shown that tropism is only one of at least three types of oriented movements. Kuhn, a well-known experimenter in this field referred to tropisms as tropotaxis.

REFLEXES

A reflex is an invariable response to a particular stimulus, examples of which are the closing of the eyes when a particle of dust is about to fall into them, and the speedy withdrawal of the hand on touching a very hot object. The essential characteristics of the reflex are that no volition is involved in the performance of the action and that the awareness of the stimulus or even of the response itself occurs only after the evocation of the latter. However, some reflex actions are partly under volitional control or can at least be held in check for a short time as in the case of coughing and sneezing.

The anatomy of the reflex appears to be simple, the neural pathways responsible for them leading directly from the receptors to the effectors via the spinal cord so that incoming messages trigger off the specific responses without their having to pass through cortical centres. In the case of those reflexes which are partly under voluntary control, the neural pathways responsible for them will also have channels leading through the cortex.

This oversimplified description of reflex action is liable to give the impression that reflex mechanisms are disparate systems each acting by itself without having much coordination with the others. That this is not so was demonstrated by Sherrington who, using dogs as subjects, stimulated simultaneously two opposing reflexes whereupon only one of them was elicited the other being inhibited.

There are also chain reflexes in which the end point of one reflex is the stimulus for the next in the series, an example of which is the act of swallowing.

The Conditioned Reflex: The theory of the conditioned reflex was first formulated by the Russian physiologist Pavlov. Pavlov based his

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theory on the results of experiments that were conducted on dogs.

The celebrated experiment which led to this important discovery was as follows: The dog subject was kept in a suitable harness in a sound proof room. As far as possible the different conditions in the conduct of this experiment were performed by "remote control", that is without there being any necessity for the experimenter to enter the room. These precautions were taken to ensure the exclusion of most of the extraneous environmental stimuli. A buzzer was sounded for a few seconds and immediately after, the dog was fed. This sequence of bell and food was repeated many times. Subsequently it was noticed that the dog began to salivate on hearing the buzzer and before the food arrived, the amount of salivation increasing as the trials progressed. The buzzer originally had no property of eliciting salivation but after it was paired with food on a number of occasions, it acquired the power to do so. This phenomenon whereby a natural response to a particular stimulus later comes to be elicited by an originally neutral stimulus, is known as the conditioned reflex. As the terminology used in this theory is rather exclusive, one can do no better than to define all the terms.

In the experiment described above, salivation is the natural response to the stimulus represented by the sight of food; therefore the response and stimulus respectively are known as the *unconditioned response* and the *unconditioned stimulus*. The sounding of the buzzer, which was originally a neutral stimulus in so far as the salivary response is concerned but later comes to elicit that response, is the *conditioned stimulus*. The salivary response which occurs when the buzzer is sounded and before the food arrives (or even in the absence of food) is known as the conditioned response. It would seem strange that one has to give two different names—unconditioned response and conditioned response to the same phenomenon of salivation. But a very close observation of the experimental animals has disclosed the fact that the activities of the animals in the presence of the unconditioned stimulus and of the conditioned stimulus respectively are not quite the same. The latter usually evokes typical preparatory responses in readiness for the appearance of the former.

Pavlov noted several other interesting features about the conditioned reflex. In most of these experiments, he made suitable arrangements to weigh the amount of saliva secreted by letting it fall drop by drop on a platform attached to a sensitive balance. By this method he found out that even when another stimulus, somewhat resembling the conditioned stimulus but not quite the same, was presented there was a secretion of saliva but less in amount. The more the similarity of the two stimuli to each other, the more comparable in quantity the secretion of saliva. From this finding another important concept was introduced, that of the principle of *generalization*. This confusion between stimuli, if generalization could be referred to as such, persisted only during the first few presentations of the two stimuli. If always the correct stimulus was followed by food but not the other, the salivary response occurred only to the former and not to the latter. At this stage *discrimination* is said to have been established. Pavlov himself noted in another series of experiments that if the two stimuli are too similar to each other, discrimination broke down altogether and the animals showed abnormal behaviour which has since been termed "experimental neuroses". Thus generalization occurred only in the earlier stages of conditioning but discrimination was evinced during the later stages.

Pavlov also found that if the conditioned stimulus was not followed by the unconditioned stimulus—that is if the sounding of the buzzer was not followed by food—for many trials, then the conditioned reflex grew weaker in strength till at last no response occurred. This is the phenomenon known as *extinction*. However, if the dog was removed from the experimental situation and allowed to rest for some time, on resumption of the experiment, it salivated again when the bell was rung —that is, the conditioned reflex showed *spontaneous recovery*. If even after this the salivary response is elicited without presentation of the unconditioned stimulus, the spontaneous recovery becomes weaker and weaker till at last none occurs. At this stage complete extinction is said to have occurred.

All these experimental findings seem to demonstrate that to keep the conditioned reflex at optimum strength, the conditioned stimulus must always be reinforced (that is, followed by the unconditioned stimulus which is sometimes referred to as a reward). The concept of *reinforcement* is a very important one in all conditioning experiments; the general law regarding this seems to be that reinforcement strengthens the conditioned reflex whereas the absence of reinforcement weakens it. The effects of delayed reinforcement, in which experimental condition the buzzer was sounded but the food arrived only after a few minutes, also differed as the trials progressed. At first the dog watched expectantly throughout the delay period but later on at the sound of the buzzer the dog hardly gave any sign of interest, salivating little if any during the first part of the enforced delay. Towards the end of the delay period it became alert and started salivating copiously. This showed that the dog had learnt to inhibit the response till the last possible instant and this phenomenon has been termed the *inhibition of delay*. One important thing to be noted in this experimental condition is that the buzzer was continuously sounded throughout the delay period till the food arrived. In another experiment which was designed to demonstrate trace conditioning, the buzzer stopped sounding during the short delay interval and after this brief silence, the reinforcement arrived. As the name implies it was thought that in this case the association established was between the memory trace of the sound of the buzzer and the un-conditioned stimulus (food).

Almost all the common animals have been used in conditioning experiments; these include guinea pigs, rats, chickens, chimpanzees, worms and snails. One of the earliest conditioning experiments on human beings was performed by J. B. Watson who founded the behaviourist school of psychology. A child of eleven months (Albert) who was also very fond of his pet rats, was the subject of this experiment. Whenever Albert attempted to play with one of his rats a loud noise was made very close to him. After a few trials Albert developed a fear of the rat. Finally, he could not be persuaded to touch it or to go near it. This conditioned fear which was first established towards rats later generalized to all furry animals and even to fur coats. Extinction of such a conditioned fear has recently been demonstrated by Jones. This was accomplished by presenting the rat in the far end of the room when the child was engaged in eating food that he particularly liked. Gradually the rat was brought nearer and nearer till at last the original approach-response towards the pet was re-established. Thus both the conditioning of a fear response and its extinction have been demonstrated using children as subjects.

The type of conditioning used by Pavlov has come to be known as classical conditioning to differentiate it from another kind known as instrumental conditioning a brief account of which will be given here. Skinner (1932, 1938) devised a problem box to be used with rat subjects. Inside the box was a bar mounted at a convenient height; the manipulation of the bar delivered a simple pellet of food into a tin tray inside the box. A naïve rat first introduced into the box would run here and there exploring its contents. However, after a time it may happen to press the bar accidentally causing a pellet of food to be delivered, whereupon it would eat it. But it is reasonable to assume that the rat would not immediately associate bar-pressing with the delivery of food. When the sequence bar-pressing-food is repeated a number of times, conditioning would be established and the rat would continue to press the bar so long as it is hungry and the food is delivered regularly. If after some time the delivery of food pellets is discontinued, the rat gives up pressing the bar after a number of such non-reinforced trials. This state of affairs would represent extinction. A removal from the experimental situation for a brief interval would cause spontaneous recovery.

This type of conditioning is known as instrumental conditioning because the occurrence of the to-be-conditioned response (bar-pressing) is instrumental in procuring reinforcement. There are a few important differences between Pavlov's classical conditioning and Skinner's instrumental conditioning which is also known as operant conditioning. In classical conditioning the food (unconditioned stimulus) is presented irrespective of the kind of response made by the subject to the conditioned stimulus. This is not possible in instrumental conditioning because the bar-pressing response has to occur before the unconditioned stimulus can appear. Another important requisite in instrumental conditioning is that the response that is instrumental in producing the reinforcement should not only be in the repertoire of the subject but also be likely to occur in the experimental situation; that is the response should be one which the animal is likely to make in its exploratory activities. Unlike classical conditioning experiments there is far more scope in instrumental conditioning situations to vary the pattern of reinforcement. For instance, all the bar-pressings can be rewarded by food, or reinforcement can be given after random intervals when it would be known as intermittent reinforcement. *Fixed-interval* reinforcement would refer to a condition in which reinforcement occurs after fixed intervals of time irrespective of the number of responses occurring during the interval. In *fixed-ratio* schedule, the reinforcement is arranged to occur after every series of a pre-determined number of responses. The differential efficiency of establishing instrumental conditioning using the various schedules of reinforcement described above, is usually determined by the number of non-reinforced trials required for extinction to a particular criterion. It is generally found that intermittent reinforcement is more effective in establishing greater strength of conditioning than reinforcement given on every trial.

There is one experiment which illustrates the interesting effects which can be obtained in some types of instrumental conditioning situations. A hopper mechanism was built into a pigeon-cote so that at regular intervals, a small quantity of grain was delivered. The experimenter then left a number of pigeons in the cote for a few hours. Coming back afterwards, he found the pigeons adopting the most comical postures; some were walking about with their heads held high; some were shaking their heads to and fro and others were hopping on one leg. The explanation for these ritualistic acts was quite simple. The reinforcement, coming as it did, after fixed intervals may have occurred just as a pigeon was raising its head or when another was hopping on one leg. During the first few trials, by sheer coincidence, the same actions might have been performed and therefore conditioning was established. For instance, the pigeon which received food after raising its head, used this particular act as the response instrumental in procuring reinforcement. This type of behaviour consequent on an accidental pairing of a particular action with reinforcement, has been referred to as *superstitious* behaviour by Skinner.

THORNDIKE'S LAWS OF LEARNING

The theories of E. L. Thorndike regarding learning in animals and men are interesting not only on account of their originality but also because they raised a thick crop of criticism which led to a prolific amount of fruitful research. One of his earliest laws, the *law of exercise,* states that the repetition of an action facilitates its future occurrence and its disuse over a period of time causes it to be forgotten. There are also two subsidiary laws, the *law of frequency* which states that the extent of facilitation varies directly with the number of repetitions, and the *law of recency* which postulates that the more recent an action the greater its facilitation with exercise.

Many activities which are repeated every day become quite automatic after a time; that is, their performance becomes possible without effort and without conscious application. Typing and driving a car are two examples of such skills developed to a high standard due to constant practice. When learning is carried on even after reaching a specific criterion, overlearning is said to have occurred. Any activity which should not be forgotten, has to be overlearned. For instance the multiplication tables which a child acquires over a prolonged period of painful effort, later becomes a part of his automatic response system.

The phenomena referred to above are known to every one and appear simple enough to understand. On the other hand, giving a theoretical explanation to it is not such a simple matter. Some early theorists explained facilitation consequent on repetition in the following manner. Perception causes an electrical discharge in the particular area of the cortical neuron system stimulated. Successive presentations of the same stimulus would cause neural currents in the same area resulting in easier conduction over the area already stimulated. This process has sometimes been compared to the scooping out of a valley by a river due to the continual flow of its waters. However, evidence for structural changes in the neural cells as a direct consequence of electrical conduction cannot be said to be conclusive. It is also clear that as synapses are the junctions where neurons have functional continuity, it is at the synapses that one must look for the occurrence of physical changes. It is quite probable that the repeated use of a particular neural pathway may have the effect of bringing the elements at a synapse to closer proximity by amoeboid growths at the ends. Just as an electric spark would jump a smaller gap with greater ease, the effect of bringing the neurons closer together at the synapses would be to facilitate conduction across the specific neural synapses which had been repeatedly used.

Thorndike had to revise his law of exercise when experimental evidence as also observations of activities in every day life proved that mere repetition of stimulation is not quite enough to consolidate learning. For instance, in the extinction of a conditioned reflex, forgetting occurs even when the learned act is repeated. Many experimenters have demonstrated that the desire to learn, and an absorbing interest in the material to be learned, are factors which promote retention rather than mere repetitions. Some recent investigations into the causes of the likes and dislikes of school-children as regards school subjects, have demonstrated that a large share of the responsibility for these preferences may be traced back to the teachers who handled these subjects. Dislike of a particular teacher or of his methods also generalizes to the subject he teaches. Lack of interest is sometimes shown by the fact that despite a great deal of application by students on a particular subject before an examination, once it is over they may easily forget most of the relevant details.

Passive repetition has, however, one important role to fulfil when such repetition helps a person to eliminate disconcerting habits and faulty movements relating to a skill. Knight Dunlap refers to this procedure as negative practice and claims that speech defects, mannerisms and wrong spelling are particularly amenable to this method. All this experimental evidence makes it seem as if repetition is only the neutral base, but what makes it effective may be the attitude of mind which goes with practice.

The Law of Effect: Thorndike's original law of effect formulated that behaviour which was rewarded tended to persist and to be learned, whereas behaviour which was punished tended to be eliminated from the repertoire of the organism concerned. In the actual enunciation of the law, Thorndike referred to a satisfying state of affairs which resulted from success or reward, and to an annoying state of affairs which was consequent on failure or punishment. However, these words were meant to describe only the effects of certain stimuli on the behaviour of the organism and did not imply any subjective description. A very important weakness in the law of effect as it was first formulated consisted in its failure to explain how an action (reward or punishment) which was performed subsequently could have a backward effect in strengthening or weakening a piece of behaviour which occurred before it.

The findings of a number of experiments using animal and human subjects seemed to show that reward was more effective in making an organism learn a piece of behaviour than was punishment in deterring it from pursuing a particular type of behaviour. In other words, the effects of reward and punishment are very often not exactly equal and opposite.

A simple experiment which illustrated this principle was performed on chicks (Thorndike, 1932). In a maze-learning situation the chick had three pathways to choose from; only one of these paths led to an open compartment where there were other chicks and food. A record was kept on the tendencies of the chicks to repeat the behaviour which resulted in reward and to avoid the pathways which led to punishment. It was found that reward did strengthen the tendency to go along the same path on subsequent trials; but on the other hand punishment did not make the chick avoid taking the path which ended in confinement.

In the same year, Thorndike performed another experiment using human subjects. The subjects in this experiment were given a sheet containing a number of Spanish words each having five English words opposite it. Only one of these English words was the correct translation of the Spanish word. Each subject, who had no knowledge of Spanish, made guesses of the word which he believed to be correct. If he was successful the experimenter "rewarded" him by saying "right" and if the word guessed was incorrect the experimenter said "wrong". Words which were rewarded were repeated in the subsequent trials but so were the words which were punished.

These experimental findings have far-reaching significance in the educational field and also in criminology. If reward has more effect in establishing a socially-acceptable piece of behaviour, it would be better to reward people for performing such acceptable behaviour than instituting a penal code which may not serve as an effective deterrent in the case of anti-social people.

Trial and Error Behaviour: One of the major implications of Thorndike's connectionism is that in the learning of a piece of behaviour by men and animals, the progress is slow and gradual consisting as it does on trying out various possible courses of action and selecting those which prove to be successful. Thorndike termed this type of behaviour as trial and error learning. He performed an experiment which has since received a great deal of publicity on account of the crucial theoretical issues involved in the interpretation of its results. A cat was placed inside a cage which had a concealed mechanism the manipulation of which would open the door to permit the cat to get out and eat the food placed right outside the door. The first responses of the cat consisted of a great deal of clawing, biting and dashing about in random fashion inside the cage. During this protracted period of violent activity, the cat happened to chance on the mechanism and was liberated. On subsequent trials, not only did it succeed in getting out quicker, it also indulged in less random behaviour, concentrating its attention more and more near the location of the mechanism which would open the door. Finally came the trial in which the cat went right up to the mechanism, operated it without evincing any random movements at all and walked out.

The emphasis in this kind of learning is on the gradualness with which errors are eliminated. The cat-in-the-puzzle-box experiment described above has come in for a lot of criticism from many learning theorists especially Hobhouse and Köhler who felt that the puzzle box provided too artificial a situation to which the cat was not naturally accustomed. Moreover, all the aspects of the problem were not clear to the animal subject. Under these circumstances, it is not surprising that the cat indulged in a great deal of random behaviour and took such a long time to master the problem. In support of his contention that at least among primates this kind of trial and error behaviour may be very rare, Köhler quoted the results of a number of experiments which he conducted with chimpanzees. In one of these, a bunch of bananas was hung up on the ceiling of a hut and a wooden crate was left lying in a corner. Sultan, who proved to be the most intelligent of Köhler's chimpanzees, was set the task of getting down the bananas. At first he tried jumping up to reach the prize. Failing in this, he wandered around the hut. Seeing the box in the corner, he held it up towards the bunch of fruit and seemed to be lost in thought. Suddenly he put it down right under the bunch of bananas, climbed it and secured the fruit—all in a matter of minutes. Köhler particularly noted the suddenness with which the animal seemed to have solved the problem. In another experiment, chimpanzees had to use a long stick or join several small ones to make a long jointed stick to pull in fruit lying some distance away outside their cages. Here also the chimpanzees showed insight by which Köhler meant that they achieved the full appreciation of all the implications of a problem; he also noted the sudden awareness of the method of its solution. Later, Wertheimer a colleague of Köhler's sought to prove insight in experiments with schoolchildren by studying the ways in which children can be taught to calculate the areas of geometrical figures. He deprecated the conventional method of giving a ready-made formula to a child instead of letting him find out for himself the underlying principle.

Many psychologists do take sides in this controversy of insight versus trial-and-error in the solution of problems. But it seems more reasonable to consider both these principles as forming part of the processes which go towards the solving of problems, the degree of dominance of either depending on the complexity of the problem itself.

Instincts in Behaviour: Instincts have to be differentiated from reflex actions; the latter are automatic responses usually taking place without being guided by consciousness. An instinctive action, however, is often modifiable to some extent in order to cope with unusual variations in the environment. Instead of trying to define instinct outright it seems easier to enumerate the various aspects of it and later elaborate on them.

(*a*) An instinctive action is an innate pattern of behaviour.

(*b*) It is not very greatly modifiable to meet the exigencies due to sudden changes in the environment.

(*c*) It shows some degree of adaptability under certain conditions.

(*d*) The organism evincing instinctive behaviour has no knowledge of the end to be achieved and in this way such behaviour differs from intelligent action.

(*e*) It is a common pattern of behaviour with all members of the same species.

(*f*) It is quite serviceable at its very first appearance in that no initial learning is necessary to ensure the appropriate response, given the particular stimulus. However a piece of instinctive behaviour though quite efficient at its first appearance, is rather clumsily performed and improves with a little practice.

Let us examine each of these points separately. In the course of the life of an animal it learns many things due to voluntary effort or because of being exposed to conditions which may facilitate as well as necessitate such learning. Therefore the proper study of instinctive behaviour should be undertaken when the organism is still quite young. Or it could be reared under controlled conditions in which there are no chances of learning patterns of behaviour which the experimenter does not intend it to learn. Marais reared four generations of the South African weaver bird under canaries without giving them a chance to build their characteristic nest. When the fifth generation was set free to build nests as the individuals liked, they wove it exactly as the wild weaver bird would have done. This experiment seems to demonstrate that there are certain innate patterns of behaviour in an animal's repertoire and that these are not learned by experience.

Fabre describes how he broke up a line of pine processional caterpillars and joined the broken ends. This made them go round in circles round a flower pot, following each other for 7 days before they finally broke up. The instinctive pattern of the behaviour of these caterpillars consists in following the one in front and this behaviour turned out to be unmodifiable even though it meant repeating the action interminably without any worthwhile end being achieved. Such inflexibility in the operation of an instinctive act has also been observed in bees. If the bee-hive is moved even a short distance away, the returning worker-bees cluster round the old site of the hive and may even die of exposure; they never seem to make an attempt to locate the new site.

However, Tinbergen (1951) gives some exceptions to the unmodifiability of instinctive behaviour. For instance, the fossil wasp showed great adaptability in locating its nest in a new place even when the nest and also the landmarks were rearranged to confuse it.

Some insects and birds show instinctive behaviour which appears to be very adaptive and some careful observers report that such adaptability is not so rare as is usually imagined. Fabre removed a few nests of the bee osmia from the quarry in which colonies of them had been nesting for several generations, and placed them on his table among some shells and hollow stalks. When the bees came out of their hibernation and found themselves in a strange environment they promptly selected the hollow stalks as the best place in which to nest. Fabre also observed that the blue bottle fly always lays its eggs in the mouth of a dead bird. If the head was covered and therefore inaccessible, the fly would lay its eggs on a wound in the bird's body. If all these places were not available, it would lay on the crook of the thigh joint provided there were no feathers in that region. Only if the bird was unplucked and no other place on its body was accessible, would the blue-bottle fly give up and fly away.

Hobhouse has observed that if a bird, which usually builds its nest on the ground, finds predators lurking in the vicinity, it would build its nest on trees. Pike found that when the moorhen, which builds its nest of reed and grass, finds that the materials are not available, it would manage with a few pieces of wood and a thin lining of grass.

Insects go through a whole repertoire of very complex actions in which each phase follows its predecessor with clock-like precision; the fascinating thing is that the individual which performs these actions not only does so for the first time but it also has had no opportunity of observing similar behaviour by other members of the same species. Again, it is Fabre who tells us of the capricorn beetle the larva of which performs the most intricate actions obviously without any idea as to the end to be achieved. The larva bores a neat tunnel from inside the wood leaving only a thin layer on the outside which can easily be bitten through by the newly-formed beetle. Then it makes a soft lining with wood pulp and builds a door just thick enough for protection but not too strong for the adult beetle to break through. Finally, it faces towards the entrance and turns into a pupa. In the course of its preparations so many factors are taken into account each action seemingly performed with foresight that it is difficult to believe that these actions are not guided by intelligence. For, if we were to grant intelligence to this behaviour, the cerambyx larva would be one of the most intelligent of creatures, which obviously it is not.

Instinctive patterns of behaviour are common to all members of the same species. Thus all cerambyx larvae would make tunnels in the trunks of trees, and all blue-bottle flies would lay eggs on dead birds; all moor-hens would build nests of grass and rushes; all weaver birds would build elegant, streamlined nests of identical patterns using the same movements.

We said in the beginning that all instinctive actions are quite serviceable at their first appearance and that these patterns of behaviour develop even when individuals are isolated. For instance, when Scott reared Baltimore orioles in captivity where they had no chance to hear the wild orioles sing, the captive ones developed into good singers. Nevertheless, their songs did not have the same quality as those of their wild brethren. Thorpe performed a similar experiment on the English chaffinch and found that birds reared in captivity could sing in exactly the same way as those which had the opportunity to hear other birds sing. And almost everyone has observed the duckling plunging into the water and swimming well at the first attempt. On the other hand, there are some animals higher up in the phylogenetic scale which have to learn many patterns of their behaviour by imitation.

The serviceability of instinctive operations even at the first try does not mean that there is no scope for improvement. Even the ducklings which are sometimes quite clumsy during their first encounter with water, perform rather gracefully after a few hours of practice. Similarly, most fledglings on their first attempt at flight find themselves unable to avoid obstacles and come to grief before long; their landing also is a heavy flop-down. After a few hours of practice at solo flying and of watching their parents perform they are able to fly as well as any other bird. However, the first attempts at flight have to have a certain minimum efficiency which would help the birds to escape from predators; otherwise the survival of the species would be in jeopardy.

The problem of teasing out and identifying individual instincts, particularly getting some answer to the question of how many instincts there are, has always exercised the thinking of psychologists. A great amount of work in this field has been done by McDougall who describes instinct as "an innate disposition which determines the organism to perceive or pay attention to any object of a certain class and to experience in its presence a certain emotional excitement and an impulse to action which find expression in a specific mode of behaviour in relation to that object". His original list contained 14 instincts to which he added some more to bring it up to a total of 18; these are:

Escape
Combat
Repulsion
Parental
Migration
Appeal
Sex
Curiosity
Submission
Self-assertion
Gregariousness
Food-seeking
Acquisition
Construction
Laughter
Comfort
Rest or Sleep

and a group of very simple propensities serving bodily needs.

In discussing some of these instincts we have to bear in mind that McDougall held that every instinct has an emotional core which makes itself manifest whenever the instinctive behaviour is in operation. This concept of the inevitability of an emotion accompanying instinctive action has caused a great deal of controversy. But whether we accept this or not, some of the instincts can be studied especially where these seem to be present in human behaviour.

In the description which follows, some of the instincts have been dealt with in detail, not necessarily in the order of their importance. But it cannot be gainsaid that the whole question of survival and preservation of any species depend on the sex and parental instincts which are therefore closely inter-related. McDougall has described the parental instinct as nature's brightest and most beautiful invention. Even in the lowliest of animals we see this pre-occupation of the parent with the question of the welfare of the offspring. Whether parental action springs from purely instinctive sources or not, the end result cannot be underestimated because it ensures the continued preservation of the young one. The care of the young is closely bound up with the capacity of the parent to know when the young one is in distress. This seems to be an obvious restatement of what everyone knows, but when we do really study examples of animal behaviour this does not seem to be so very obvious at all. The domestic hen, for example, becomes aware of the distress of a chick only if and when she hears its cry of distress. But the sight of the chick writhing in apparent distress inside a glass bell jar in full sight of the mother fails to elicit any maternal solicitude. Even some apes fail to register much sympathy in a similar situation. On the other hand, in the case of human beings, seeing another person suffer is enough to engender feelings of sympathy. This is induced sympathy. There is also another kind of emotion, present in man but not in other animals, engendered on seeing another person about to run into some danger of which he himself is quite unaware. An observer watching a very young child crawling on the edge of a precipice may experience this kind of selfless, disinterested emotion.

Civilized and sophisticated behaviour depends on the expectation of what is acceptable to the other party and also on the detection of emotion in others. In most modern societies any overt manifestation of emotion is taboo and hence efficient inter-personal relations depend on the ability to detect these emotions even when these are insufficiently expressed. Man's gregarious nature makes it essential that he identify himself with the emotional life of those around him. A leader's success depends on the extent to which he can assess the feelings of his followers and on the degree of adaptability he can bring to bear on his own emotionality. Further, he has to induce just those emotions which are expedient to the community in the given context. On the side of the followers, the essential requisite is to identify themselves with the emotional tone which the leader is trying to convey. Though altruistic, disinterested sympathy is present in human beings its evocation is of sufficiently supra-threshold strength only when the stimulus is adequately intense. This may be one of the reasons why western missionaries trying to raise money for their work in less well-developed countries, present the most gruesome pictures of the conditions supposed to exist there. By doing this, they succeed in raising feelings of utmost pity in the minds of the would-be-donors. The question whether these methods, which savour of excellent psychology, are morally justifiable is best left to the philosophers.

Parental instinct is one of the most important of all instincts but its operation differs according to the cultural environment in which it is studied. Evidence for such diversity comes from the pen of Margaret Mead who made a special study of tribal customs in her anthropological expeditions. The Arapesh for instance, are over-solicitous about the welfare of their children and so protect them as much as possible from the harsh realities of life, with the result that the adults never really grow out of their dependence. In the Mundugumoor tribe whose territory lies only a hundred miles away from that of the Arapesh, even the most maternal of activities as the nursing of a baby, is peremptory and is the occasion for a tussle between the mother who would rather be rid of the nuisance, and the baby who wishes to snatch at the least opportunity to draw nourishment. The Solomon Islanders combine laziness to rear children with an over-developed parental instinct; this strange combination of traits makes them purchase babies from other tribes.

The sex instinct which is very closely associated with the emotions of love and tenderness seems to be quite fundamental in the affairs of men and animals. The instinct to reproduce is closely bound with the maternal instinct and these two together achieve the perpetuation of the race, at the same time ensuring maximum chances for the protection of the individual.

Modern societies in Europe and America differ in the relative importance given to either sex. In the German society for instance, the man enjoys many privileges and the woman is very often content to act a secondary role, obeying her husband in most things and letting him plan out the course of their lives. This type of familial set-up is very common in Eastern countries especially in India and Japan. In America, the male while not occupying a subsidiary role, is content to let the woman have a greater say in the run of the home. One finds still another system in Britain where a silent striving for dominance by either sex exists, the woman being most vociferous in the defence of her rights possibly on account of her recent elevation to an equal status with man. Margaret Mead has compared some other societies in various parts of the world. Among the Arapesh both men and women are uniformly gentle, any competition between the sexes being frowned upon. The whole cultural atmosphere is permissive and their social system seems to be democracy with a vengeance. But their lack of aggressive traits has very little survival value and there has been recent evidence that other communities with no such scruples as the Arapesh, have progressively encroached on their goodness. The Mundugumoor people have habits of life and thought which are quite different from those of the Arapesh. Among them, both men and women are very aggressive, no demonstration of tender emotions being manifest even when the mothers are nursing their infants. This kind of hostile atmosphere permits the growth of the maximum amount of aggressiveness. Female supremacy is seen among the Tchambuli. Here the women do all the jobs and bestow their attentions on the coy men who passively wait for these favours.

From the account given above we have to conclude that there cannot be what is known as "typical" behaviour applicable to all the cultures of the world. What is normal in one society might be considered deviant behaviour in another. That is why one has to be careful about passing judgments on an observed piece of behaviour before a thorough investigation is made of the cultural background of the society concerned. But typical instances of behaviour in particular societies do seem to demonstrate that cultural differences may lead to variations of behaviour from society to society.

Every one is familiar with the phenomenon of children acquiring all kinds of odds and ends which can have no value from the point of view of utility or aesthetic appeal. A refined form of this instinct is found to be operating when adults collect stamps, photographs, paintings and first editions. In all these collections one can trace the inherent satisfaction which comes out of possession outweighing all other considerations. When acquisition of useless materials is carried on even at the expense of other basic comforts of life, then we have an extreme case in point. The miser, however, does not hoard valueless things; he accumulates money which usually has the ability to provide comforts but gives him the sense of power from mere possession of it. In the animal kingdom the collection of materials may be an instinct inherent in the individual as in the case of the tame squirrel which even though regularly fed, would nevertheless store nuts under carpets or in dark corners. In the laboratory, many experiments have been performed to demonstrate how rats would hoard food pellets even after their immediate needs are satisfied. Collecting of odds and ends, specially of shiny things is a well known trait of the magpie.

Several writers seem to think that although the acquisitive instinct cannot be denied in man, it is largely modified by cultural patterns, as sometimes a negative acquisitive tendency seems to operate. That means that instead of hoarding and preserving objects, in certain societies, individuals indulge in an orgy of destruction in order to enhance their prestige in the eyes of the rest of the community. Benedict describes how among the Kwaikuitl Indians, a man demonstrates his status by inviting a large number of distinguished people of the tribe and building a huge fire for their benefit. This fire would be no common one either, it being usually fed with precious palm oil. The climax of the party comes when the house itself is allowed to burn down with everything in it. The greater the conflagration, the more the man's prestige grows. The guests return the feast and try to outdo their erstwhile host in the amount of property destroyed. It would appear then that the Kwaikuitl Indians collect property only for the sake of deliberate destruction later. However it is doubtful whether this would constitute a destroying instinct. For one thing property has first to be acquired before the orgy of destruction can take place and this part of the proceedings surely demonstrates an active acquisitive tendency. About the fact of the actual destruction of property itself it may be possible to give an explanation along the following lines. The sentiment of self-regard being the most important aspect of an individual would be the nucleus around which his personality is built. Thus a man may strive hard to do many things which would satisfy his desire for power and the need to be loved. The self-regarding sentiment is all powerful in its operation and it may suppress any other instinct which may crave satisfaction in a contrary direction. Perhaps the destructiveness of the Kwaikuitl Indians stems from this reason. Since in that culture it somehow came to be established that a man's greater prestige depends on the greater degree of destructiveness he could accomplish, the practice became ingrained. Another similar example in which the self-regarding sentiment leads to an action against one's own interest is shown by the defiance sometimes shown by the junior employee towards his employer even at the risk of losing his job. After a period of prolonged acquiescence, the particular young man may feel the need to assert himself with disastrous consequences. Some types of juvenile delinquency and the institution of 'teddy boyism probably stem from the motive power of the self-regarding instinct.

Pugnacity is one of the most familiar of all instincts present in a basic form both in men and animals. The tendency to attack when the need arose and also to defend oneself as also one's property, must have helped the survival of the race in days bygone when there were no deterring influences as the police force to keep lawless elements in check. In the present day however, overt manifestation of pugnacity is looked upon with contempt and disfavour. Though verbal attack within a certain framework of propriety are allowed by convention, it is not permissible to indulge in private or public abuse. Physical pugnacity, therefore, receives an outlet through games like rugger and sports like boxing or wrestling. Overt release of verbal pugnacity is provided for by many modern institutions like the parliament and debating societies where a person may, in a decent sort of way, attack one's opponents. If pugnacity can be identified with aggressiveness, Miller and Dollard have a very interesting thing to say about it, that aggressiveness is the result of frustration. The concept of an ideal temperament as envisaged by Western societies includes a generous amount of pugnacity. In all levels of human relations not only is a certain amount of aggressiveness tolerated but it is also considered essential in a person's make-up if he is to be accepted by his companions.

Self-assertion and submisiveness are two instincts the algebraic sum of the strengths of which decides whether a person would lead others or be a follower. Though these two instincts operate in opposite directions, they go together but in differing amounts. Adler has advanced a very interesting theory according to which all human beings have the tendency for self-assertion to offset a feeling of inferiority which latter trait develops early in childhood. The young baby is helpless and is always dependent on others for the satisfaction of its basic needs. In early childhood and even later, this dependence continues and creates a sense of inadequacy. This feeling in turn spurs a person on to greater efforts not only towards self-improvement but also to acquire power over others. Whereas self-assertion and pugnacity can easily be explained this way, it may sometimes appear hard to explain why submissiveness is evident in some people. If we invoke cultural and familial conditioning as being responsible for differences in the degree of self assertion in different individuals, explanation of this phenomenon becomes not only plausible but easy as well. Thus in a community which is subjected to terrific competition and external pressures, only an assertive, overbearing sort of individual has the chance of survival in any comfort. The very conditions of life in such a society would spur on all members of such a community towards greater aggressiveness. The Mundugumoor society demonstrates this quite well. On the other hand in a culture tucked away inaccessibly in a Shangrila, unassailable by enemies, a permissive type of social intercourse is bound to develop. The people of such a community may then turn to purely cultural and intellectual pursuits and in course of time get used to a gentler way of life. The Arapesh tribe is an example of this phenomenon. Turning to history we can multiply instances of how, many ancient civilized communities went into decline because long periods of peace and security turned them from aggressiveness with the result that their less civilized neighbours subdued them easily.

It is often said that habitual submission is a cowardly trait and is a sign of weakness; at the same time it is usual to think that abnormal self-assertion may be a mechanism to offset a feeling of inferiority. It would be interesting to extend this line of thought and say that submissiveness as well as self-assertiveness stem from the same feelings of inferiority but that in the former case the person concerned has given up the struggle whereas in the latter he is making an attempt to overcome it. Popular opinion sometimes tends to relate greater aggressiveness with superior intelligence. But this is not quite true either, this combination being rather the exception rather than the rule.

McDougall has included laughter also among the instincts; many theories have been formulated about it. McDougall's theory is in two parts, the first dealing with the reason for laughter and the second with the effects of it. Life is full of minor misfortunes and our disinterested sympathy may force us to feel with and for another person undergoing these mishaps. Such sympathetic distress could add up and make life intolerable by its cumulative effect. Laughter in such situations provides a welcome break from continued depression. Not only can we laugh at other people's misfortunes but we can also laugh at ourselves; and as for the effects of laughter, it cannot be denied that it is entirely wholesome and exhilarating. The physiological concomitants of laughter such as rapid respiration and increased circulation of blood to the head are exactly the same as those which accompany feelings of joy. Therefore, laughter produces a sense of pleasure and a state of euphoria. Just as James-Lange theory conceives of emotion as the end-product of an instinctive operation instead of the action following close upon emotion, McDougall also implied that laughter creates the conditions for a state of euphoria rather than following from it.

Bergson feels that laughter is provoked when we see a man behaving in a ridiculous fashion, more resembling an inanimate object rather than an animate being. Therefore, laughter is thought of as serving the role of punishment for a man's clumsiness. At first sight this definition seems to provide an adequate description but on second thoughts we can analyse a large number of laughter-provoking situations and not find any sign of people acting like inanimate matter. Some situations which do include such clumsy behaviour move us to distress rather than to laughter.

Freud's theory of laughter states that it arises from the "economy of expenditure in inhibition" by which he means that as most jokes imply indirectly an indecent idea which cannot be expressed openly, a kind of vicarious pleasure is experienced on hearing such a joke. In short, what is taboo in social intercourse causes laughter when presented in a disguised form.

Whatever be the origin and meaning of laughter, its social implications are far-reaching. The fact that laughter in a normal person is easily engendered in company than when he is alone perhaps explains why it serves to unite many people under a common bond establishing sympathetic communion very quickly. This is why an amusing companion is so greatly sought after and a humorous speaker held in such high esteem. It is also a fact that laughter-provoking situations vary in different cultures. A situation which would send people into guffaws of laughter in one society may hardly raise a titter in another. Film and play-producers, not to speak of authors, all have to take this into account when they plan entertainment for the public. Finally, laughter can also be used as a measure of gregariousness, people who seldom laugh making very unsatisfactory companions despite other sterling characteristics of heart and head which they may possess. People deficient in laughter have been found to be either extremely cold or too highly strung. In either case their unwillingness to laugh (or, is it inability to do so?) with other people shows a certain lack of identification with the interests of the community. To infuse confidence in others, laughter is invaluable. Persons with a good sense of humour find it easy to step into the role of leadership because other people are ready to accept them in that role. A leader without the capacity for laughter can spread greater panic and gloom in a community than are caused even by natural calamities.

The foregoing account would have given the reader a fair idea about the concept of instincts but it must be remembered that there may be other ways in which motivational factors can be explained. The word instinct itself, in the way in which it was described in the preceding paragraphs, does not commend itself to several psychologists. Hebb, for instance, talks of drives, biological drives (appetitive drives) such as the need for oxygen and water, maintenance of a constant body temperature, the sex drive and the avoidance of bodily damage. Besides these, there can also be acquired drives. Hebb described drive as having two functions, the arousal function which induces a state of excitement, and the cue function which determines in which direction the drive should act. Among the drive theorists many believe only in a single drive the degree of arousal of which determines the quality of the reaction. The multi-drive theorists are more numerous and their ideas when boiled down to simpler terms read very much like McDougall's theory of instincts.

Fear: While it is largely true that fear is innate (given at birth) it is however not the whole truth. It has a partly innate element and it is also acquired as a result of the learning process throughout one's life. The very young baby which has had no experience of loud noises would show definite fear reactions at a sudden unexpected sound. The fear of snakes is another behaviour pattern which has been demonstrated with children and chimpanzees even when these subjects had not seen a snake before. The results of many experiments in this field seem to indicate that revulsion towards and fear of creeping things in general are mostly innate. Other innate fears include fear of the dark, fear of strangers, and the fear of seeing dead or mutilated bodies. Though these fears are clearly maladaptive in the modern world, it is not difficult to think how these might have been useful in the dawn of human existence when life was full of dangers.

However it is also quite true that fears may be acquired throughout one's life by a process of conditioning as was demonstrated by Watson when he induced the fear of furry animals in a young child. There is evidence now that most phobias which plague the lives of many people must have been established initially by conditioning. The peculiar characteristics of the fear reactions are that they are comparatively easy to condition and what is more they are very difficult to extinguish. These characteristics are clearly demonstrated in the acquisition of avoidance conditioning.

But sometimes it is hard to say whether a particular fear is innately given or learned. For instance, baby chimpanzees and human children show clearly their fear of strangers but if they are reared away from contact with people they don't evince any fear when they see someone. So, it seems that young animals develop fear of people only after having had experience of them. Here again, it is difficult to separate the innate element from the acquired.

Pain: Some recent experiments seem to indicate that pain is not something which we are able to perceive due to an innate capacity but that we learn to feel pain. In one such experiment baby chimpanzees were reared in darkness with carboard padding on their arms and feet to prevent their experiencing any tactile sensations. Later, when these chimpanzees were pricked with pins they showed no pain reactions as other chimpanzees do. Dogs reared in isolation under very sheltered conditions have been known to keep their noses in the flame of a candle for as long as ten minutes even though their flesh was being roasted.

However the biological function of pain is evident. It is to make us aware that the tissues in a particular part of our body are being damaged; this awareness helps us to withdraw from the dangerous situation. If it has survival value, as it obviously does, we would like to think that like all other instincts which are adaptive, pain should also be innate in us. But the two experiments described above seem to dispute the fact. In the light of these facts one can only conclude that pain has two aspects—innate and acquired.

The Exploratory Drive: When a hungry rat is placed in a maze, it will perform a great deal of exploratory activity presumably directed at the finding and consumption of food. Here the motivation is hunger, and exploration is the means to an end. Hence it cannot be described as an exploratory drive. On the other hand, if a rat does go about exploring immediately after it has had a good feed and had slaked its thirst, the motivation behind that action obviously cannot be physiological.

The tendency to explore has been demonstrated in a Warden's puzzle box which consists of two compartments connected by an electrified grid. The starting position for a rat is in one compartment and the reward in the other so that the animal has to cross the electrified grid to obtain the reward. After a few trials the animal learns not only that there will be a shock en route but also that on the far side of the shock it can attain safety as also a reward. Nevertheless the normal rat, as often as not, has been seen to come out slowly from its box and to explore the nearest strip of grid in a gingerly fashion. Exploratory drive seems to be compounded of curiosity and also of fear. Chimpanzees as also young children show great fear reactions when an experimenter puts on a mask. In one such experiment they screamed for dear life and fled to safety in a corner of the cage. After a little while they slowly peeped out to ascertain whether the mask was still in evidence. Valentine (1957) describes a similar experience with his own children. During playtime, he would go down on all fours, roar like a lion and chase his young children all over the house. They used to show genuine signs of fear and sometimes scream with fright; but the moment he stopped playing "lion", they would dry their tears and beg him to start all over again.

In all the above instances as also in the tendency of most people to see gruesome sights like mutilated bodies, we can trace a strong ambivalence of feeling, that of curiosity and fear. This ambivalence seems to add some spice to life as is shown by the fact that most of the popular modern sports have an element of real or imaginary danger in them. The chute down which a young child slides and the water-skiing which some adults fancy have an element of danger and therefore evoke a thrilling sensation. Hebb considers work also a kind of ambivalent reaction.

Pure exploratory tendency in an animal has been demonstrated by Harlow (1950) who left a simple mechanical puzzle consisting of a padlock and chain attached to a board, in the cage of a chimpanzee. He watched the chimpanzee pull the contraption to pieces whereupon Harlow assembled it again. The chimpanzee dismantled it again. This assembling and dismantling went on interminably till the experimenter gave up in sheer disgust, but the chimpanzee appeared not the least whit bored. In other experiments conducted by Harlow, chimpanzees even gave up eating when they became engrossed in a mechanical puzzle. Experimenters using rat subjects invariably find that when these animals have mastered a particular maze, they would take a different route to the goal at every fresh trial presumably to satisfy their curiosity.

As no physiological need has been found to be reduced by mere exploration, we have to conclude that some psychological factor is involved. At least in higher animals, there is need not only for bodily exercise but also for intellectual activity and perception of the environment. Sometimes when sensory experiences from the environment are entirely cut off, human beings would find it very unpleasant to carry on. In an experiment conducted in the U.S.A., students were paid 20 dollars a day to do nothing but lie down on a comfortable bed in a sound-proof room. Their eyes, ears and hands were padded to minimize environmental stimuli from reaching the sense organs. The subjects had to keep this up as long as possible with only very short breaks. All the subjects in this experiment were in need of money but none could keep it up longer than 6 days.

HOMEOSTASIS

Homeostasis is the process by which a constant internal state is maintained in an organism. The body needs to maintain a constant level of oxygen, a constant temperature and the right concentration of essential substances in the blood. When any of these is disturbed, certain processes are set up which automatically bring the body back to the normal state. The following are some instances of homeostatic processes.

1. When somebody is running fast or doing some work which entails great physical effort, more oxygen is necessary to speed up the metabolism of sugar. To take in more oxygen breathing becomes very fast. If this activity is continued too long, the need for oxygen becomes more than what can be supplied by rapid inhaling. Panting then sets in, as a result of which the person has to stop his activity. Thus the ratio of oxygen to carbon dioxide in the blood is kept at a constant level.

2. Many of the reflex mechanisms of our body have to do with maintenance of a uniform temperature and certain receptors in the brain stem have the function of adjusting the body temperature. After a spell of heavy work or sport when the body temperature tends to rise, there is profuse sweating; when the sweat evaporates, considerable amounts of heat are absorbed from the body. Thus the temperature is reduced. When the body heat falls due to inadequate protection against the cold or due to any other reason, a reflex mechanism of shivering is initiated. This causes greater metabolism with consequent increase in temperature.

3. When the substances in the blood exceed the optimum level, some internal processes are initiated which bring about a reduction of these substances. For instance in the initial stages of diabetes, a condition in which the ability of the body to break down carbohydrates is impaired, the sensation of thirst is very acute. This makes the person drink large quantities of water which subsequently leads to copious urination and thus helps to get rid of the excess of sugar. In normal people, thirst is an indication of loss of fluid from the body due to perspiration, and hunger is an indication that the stock of essential substances in the blood needs to be replenished without further delay.

Homeostasis has an important implication in cases of drug and alcoholic addiction. Under normal conditions these substances are not present in the blood-stream and the human body has no need of them. But once the habit of taking these drugs is established, the body being one of the most adaptable of mechanisms soon adapts itself to the presence of these extraneous substances in the blood stream. When this adaptation has taken place, the person concerned can be said to be an addict. Thereafter in the absence of these substances, homeostatic mechanisms operate which impel the addict to imbibe more of these substances to rectify this "deficiency". When this stage of addiction is reached in which the drugs are accepted by the body as an integral part of its chemical composition, it is very hard for the person concerned to give them up. Alcohol, *heroin, preludin* and a host of other drugs can lead to addiction. Some experimenters have found that young chimpanzees given injections of morphine every day, became addicts in about six weeks. But one saving feature is that not everyone who takes drugs or alcohol becomes an addict.

Incentives: When an animal has the need to correct an organic deficiency, the resulting drive may be very strong indeed. Thus rats deprived of vitamin B will search and search till they find food containing this vitamin. How the animal knows that this particular food will correct its deficiency is not very clear; one possibility is that the chemique of the body may make the taste of certain substances more attractive than that of others. Drive and incentive can be differentiated in that the former represents an internal state of the organism whereas the latter is an external factor which affects drive.

Various preference tests for incentives have been devised and in some of these, rats were offered choices between a saccharine solution and plain water, and between casein and ground wheat. The incentive which is favoured has the greater effect on drive. The intensity of an incentive can also be measured using various criteria. Warden's obstruction box with two chambers connected by an electrified grill presents a very convenient device for this sort of experiment. Some of the incentives which have already been tested by various experiments include:

(*a*) Food after differing periods of deprivation.
(*b*) A receptive female for a male rat subject.
(*c*) Odd things like corks, blocks, shavings and so on to evoke the exploratory drive.

Basing his experimental design on the hypothesis that the amount of work or discomfort that an animal is willing to tolerate to obtain a given incentive, would be a measure of its strength and indirectly of the strength of the drive, Fletcher (1940) performed an experiment in which a chimpanzee had to draw a carriage 18 feet to obtain a piece of banana. When the weight of the carriage was increased beyond a certain value, the animal refused to draw.

Human beings, by reason of the complexity of their lives may not evince such a simple relationship between incentives and drives as animals seem to do. In industry incentive plays a very important part in that not only must it be attractive enough to spur the worker on to the highest possible output but it must also be able to keep him reasonably contented over a period of time. Even in highly paid industries in which workers enjoy the maximum of pay and comforts, strikes are a common feature. This seems to demonstrate that material comforts alone do not engender a satisfied working community. Many more things like adequate recognition, a feeling of personal involvement in the work which one performs, are some of the important factors involved in labour relations. In these days of impersonal relationships between employer and employee, the pay packet alone seldom makes for contentment.

LEVEL OF ASPIRATION

In modern societies, one of the signs of mental and psychological well-being in an individual is the presence of the right amount of ambition. This statement does not mean that a man should always be discontented with his position at any given time and be reaching out for yet higher jobs. The well-balanced person adjusts his sights at the right level so that he can achieve his ambition without too much of strain. On the other hand, a level which is too easy to achieve would create a sense of boredom. The level of achievement which a person is aiming for, is known as his Level of Aspiration. It is a sign of internal conflict when a person consistently sets his level of aspiration so high that achievement becomes impossible. Failure in such a situation would lead to frustration and loss of self-esteem. The alignment of aspiration at the right level is a matter of skill and arises out of insight into one's own capabilities as also limitations.

Finally, the study of learning and motivation is one of the central themes in current psychological research. Factors arising from these form the cornerstone of an individual's pattern of behaviour. If this chapter has made the reader realize the enormity of the problems involved in this study as also the vastness of the field to be covered, it would have served its purpose.

CHAPTER THREE

Perception

Every moment of our lives innumerable stimuli impinge on our sense organs causing various sensations and this operation keeps us in touch with our environment. Neural impulses transmitted by the sense organs reach the brain and we become "aware" of the external object which first stimulated the organs of sense. This final awareness may be termed perception. We have to make a distinction between mere sensation, the result of the action of the external stimulus on our senses, and our awareness of the external object which caused it. This becomes important when we realize that the same sensations can cause different percepts as in the case of ambiguous figures. For instance if one keeps on looking at a Necker Cube the farthest face and the nearest one seem to change places quite frequently causing a strickingly different percept to emerge. And yet the points of the retina stimulated are the same in both cases. The Schröder Staircase is another figure which can be seen in two different perspectives.

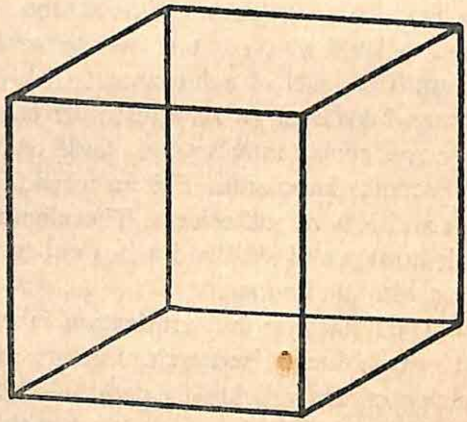


FIG. 9. THE NECKER CUBE

Examples can be multiplied to show that our perception may not always be an exact copy of the external object which causes it. There

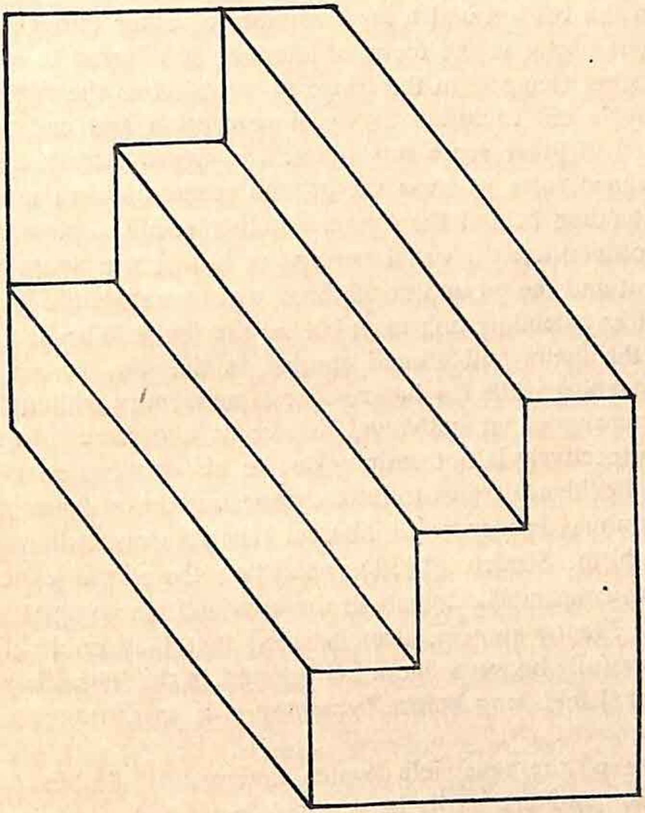


FIG. 10. THE SCHRODER STAIRCASE

is a great deal of interpretation involved in perceiving anything as can be seen from the fact that when we look at a scene in the street below or in the country-side, what we see makes a complete meaningful picture and not just a jumble of various objects, smells and colours. Hence there must be a very efficient integrating mechanism capable not only of uniting the very many sensations but also of arranging them into a coherent pattern. As a result there emerges a complete picture the meaning of which we are perfectly aware.

FIGURE AND GROUND

Every object perceived discloses two particular aspects. First there is the object itself which is in the centre of attention and secondly there is also in the background a large number of other things like the sky or sea. The object in the focus of attention is referred to as the figure and the other elements in the fringe of attention as the "ground". This dichotomy is not exclusive to visual perception and can also be demonstrated in other sense modalities. The figure usually appears with a well-defined form whereas the ground seems only an unformed expanse extending behind the figure. Another peculiar experience which is quite pronounced in visual perception is that the figure appears to be in front and the ground at the back which enables the ground to be perceived as extending unbroken behind the figure. The final difference between the figure and ground consists in that the former suggests a definite meaning while the latter suggests uniformity without specificity.

The capacity of an individual to resolve a percept into figure and ground respectively is not entirely due to his previous experience. Experimental evidence seems to have demonstrated that figure-ground differentiation may largely be an inherent capacity present in every human being at birth. Senden (1932), analyzing the visual experiences of adults with congenital cataracts in the eyes and whose sight was restored late in life by surgery, demonstrated that they could differentiate very successfully between figure and ground in the immediate post-operative period and long before becoming able to distinguish shapes of different objects.

In some of the reversible figures designed by Rubin (1921) the figure and ground can easily be reversed, but the shape first seen as the figure tends to persist as such and the other remains the ground. In an attempt to provide more experimental evidence for this phenomenon, Atkinson and Ammon (1952) presented a Rorschach inkblot to subjects instructing them to try to see a particular shape (say for instance a motor-cycle) in the blot. After they had seen the particular figure it proved to be difficult for them to see another one in the same inkblot. This figural persistence must be a saving factor in our perceptive life as otherwise chaos would obtain when figures reverse frequently leaving a person utterly bewildered. But the actual mechanism which ensures figural persistence is not very well known at the present time.

The division into figure and ground is applicable to other sense modalities as well. For instance, in the auditory perception of a piece of music, the melody is the figure and the accompaniment the ground. Vernon (1934-1935) has demonstrated that the figure in music (the melody) tends to be higher in pitch and louder in volume than the accompaniment. Most people would consider the presence of a distinctive melody as a "must" for all good music. Vernon has also demonstrated that the distinction between figure and ground is facilitated if either the melody or the accompaniment starts first.

Figural after-effects: In 1933 Gibson, noted a very popular phenomenon in visual perception. He presented a slightly curved line in the vertical position to a subject who inspected it for several minutes. After a prolonged period of inspection of the line, it seemed to appear less curved as was demonstrated by the fact that a vertical straight line appeared to be curved in the opposite direction. Gibson was able to demonstrate the same effect using flexible rods instead of lines; in this experiment subjects had to adjust the shape of the second rod to be straight. It was found that the subject after inspection of a bent road always bent a straight one in the other direction. Many variations of this experiment have been tried with the same results. In one such experiment blindfolded subjects had to pass their fingers repeatedly over a slightly curved edge. When subsequently they were required to feel a perfectly straight edge in the same way, they reported that it was curved in the opposite direction. It seems possible that the figural after-effect may not be a retinal phenomenon but a cortical one because even when one eye was kept closed during the initial presentation, figural after-effects were demonstrated for that eye also.

Köhler, seeking to give an explanation for this phenomenon, advanced a theory known as the Satiation Theory according to which figural after-effects are due to the satiation of cortical structures which take part in prolonged perception. This theory follows the general Gestalt concept of perception according to which there is an electrical potential flowing in the brain which traces a pattern representative of the external object; diffuse electrical impulses permeate to short distances outside this boundary causing the precincts of the boundary to become polarized. The electrical conductivity of the polarized area is thus lowered. When another figure is superimposed on the same retinal area corresponding to the area of maximum polarization in the visual cortex, the electrical impulses have to travel over an area of great resistance and are therefore repelled, causing a flow in the opposite side where there is no polarization.

This electrical satiation theory has come in for a barrage of criticism from several well-known psychologists like Hebb, K. R. Smith and Lashley. In an effort to provide experimental evidence in refutation of this theory, Lashley placed sheets of gold foil over the occipital area of the cortex in a monkey and drove pins into the same area in others. The idea was to short-circuit any electrical flow that might occur on the visual cortex and thereby prevent the formation of a high polarization area as formulated by Köhler. If Köhler was right, then Lashley's procedure should destroy any tendencies for figural configurations to occur. The monkey which was treated in this way did not show any such loss. However, Köhler has not accepted this evidence as conclusive and still holds that his theory has not been proved wrong. So the controversy continues.

CONSTANCY IN PERCEPTION

Intelligent people may often have wondered why certain objects appear to be the same colour in bright light as also in dim light. Thus coal appears black and a sheet of white paper appears white respectively whatever be the intensity of illumination falling on them. If the coal were to be kept in bright sunlight and the white paper in the shadow the appearance of each continues the same as before even though the light reflected by black surface can be proved to be much more than that reffected by the paper. This phenomenon whereby an object appears to be the same colour irrespective of the stimulus intensity affecting our retina is known as perceptual constancy in the visual modality.

Helmholtz (1886) and later Hering (1907) believed that this may be due to the fact that in the course of our experience with an object, we have ample opportunities of observing it under different illuminations and therefore its perception becomes a habit. Later, even while we are actually not conscious of our sensations, we unwittingly make an intellectual judgment. Hering did not entirely agree with this concept and introduced peripheral factors like contraction of the pupil, retinal adaptation and contrast as being responsible for the constancy phenomenon. According to this concept, the receiving centre of the brain—the sensorium—also gets modified when an object is seen. When the same object is seen again, it is perceived by the modified sensorium and therefore the sensation from the same object appears in a different way. But the colour we associate with an object may be the one with which we have most often seen it. Thouless (1931) has described constancy as a "phenomenal regression to the real object".

Katz (1911, 1930) made a detailed study of the different "modes" of appearance which the same colour may show depending on the object or the surface to which it belongs. He defined *surface colour* as that which appears to lie on the surface of things; the colour of a lemon would belong to this category. The sky appears as a surface far away but it usually seems just an expanse the distance of which from the observer is hard to determine. It may appear to be very close or very far away. Therefore it is said to be an *expanse colour,* sometimes referred to as an aperture colour. If any surface is looked at through a reduction tube which is a narrow cylinder or through a hole in a cardboard, the colour appears as an expanse colour. *Film colour* is that of a very thin film of material as in a spectroscope.

Constancy applies also to size and shape. When two persons are seen, one very close and the other very far away, the two persons are judged to be of the same size even though the retinal image of the person farther away is very much smaller. This is an example of size constancy in which known objects are always judged accurately in respect of size even though the size of the retinal images may vary enormously. In the case of unfamiliar objects, if the retinal image is large the object is judged to be nearer and if the image is small it is judged to be far away.

An example of shape constancy is the fact that a circle will always be seen as a circle even though in certain positions the retinal image would most certainly be that of an ellipse. An ellipse can be arranged with its long axis in a line with an observer so that the perceived figure is a circle. But the retinal image on which the percept is based is not a circle but will be a shortened ellipse. A square shape will also be seen as a square whatever be the angle through which it is turned even though in the various positions the retinal image will not be a square at all.

The Phi Phenomenon: When a motion picture is projected on a screen, there is no real movement of the figures. A number of still pictures are rapidly presented in succession and this gives rise to the perception of motion. In 1912 Wertheimer of the Gestalt school took up the study of this apparent movement which he called the phi phenomenon. He devised an apparatus for the presentation of two lines of light side by side in succession. When the interval between their respective presentations was 200 milliseconds or more, the lines were seen one after the other but when the interval was less than 30 milliseconds the two lines were seen simultaneously side by side. With an interval between 30 milliseconds and 200 milliseconds the light appeared to move from one position to the other. Wertheimer tried many variations of this experiment, as for instance having one of the lines pointing upwards while the other was horizontal both of them thus making an angle of 90°. Even then the light appeared to swing from one position to the other.

Korte (1915) continued the study of this phenomenon and formulated stimulus as well as subjective conditions under which it would be impossible to perceive apparent movement. The stimulus factors are too short a time interval between the two presentations, too great a distance between the two positions and low intensity of illumination. However, if one of the above factors is constant, the other two can be suitably varied to achieve apparent movement. The subjective factors are practice and set. It was also found by Wertheimer that at the first trial many people failed to see the movement but after some practice they were able to do so; and if a subject happened to be very critical or inhibited it was difficult for him to see the phi phenomenon.

The Autokinetic Effect: Sherif (1935-1936) found that when a subject in a perfectly dark room was asked to observe a pin-point of light projected on a screen, a strange phenomenon took place. The point of light appeared to move and when the subject was given a pencil with instructions to mark the place where the light fell on the screen, he not only failed to do so but also traced lines all over the screen. Some subjects even became sick and disoriented. This apparent movement of a static point of light in a perfectly dark room, is known as the auto-kinetic effect. Sherif explained this as being due to the absence of any "frames of reference" to which the pin-point of light could be related. Usually any object would be bounded by a frame consisting of either its own edges or of other objects in the environment. Under such circumstances, a person could easily relate the position of one object to another in its vicinity if both were visible at the same time.

Sherif tried to relate this phenomena not only to physical relationships but also to social ones. All changes of conviction entail changes of the frames of reference too because a new conviction has to be moored to an entirely different set of values which task requires radical thinking and fundamental readjustment. That is why most people prefer to hold on to the status quo with regard to beliefs and opinions.

Visual Perception of Depth: The retina is the sensitive surface of the eye on which light reflected from the objects in the environment falls. The retina being a flat surface, the image on it should also be only two-dimensional in the sense that such an image could not in any way indicate the distance of an object from the eye nor give any clue as to the relative distances of objects. And yet we are not only able to perceive the distances of objects but also to appreciate their three-dimensional characteristics. This is a fundamental problem of perception. One of the oldest explanations for this phenomenon is due to Berkeley (1710) who explained it in terms of tactile experiences. According to him we are not born with an inherent ability to perceive depth but the experience built up by handling different objects at various distances from us makes us gradually "learn" these distances. These tactual memories combine with the actual two-dimensional picture formed on the retina to give us the sensation of depth. While this explanation is quite true in some respects, it is not however the whole truth. There are certain mechanisms of the eye itself and also some characteristics of the object which partly determine the perception of depth. The most important of these are:

(1) *Accommodation*: This is the name of a process by which the ciliary muscles of the eye increase or decrease the convexity of the lens by tightening or slackening of the tension. When an object close to the eye is looked at, the convexity of the lens is increased to shorten its focal length. It is quite possible that the amount of contraction of the ciliary muscles may provide neural impulses which reach the cortex and help in the assessment of distances of the objects in the environment.

(2) *Triangulation*: As there are two eyes, when a distant object is looked at, the eyes are parallel the intention being to let the image of the object fall on the "fovea", the area of clearest vision on the retina. When the object comes nearer the eyes converge gradually in an effort to keep the image still on the fovea of both eyes. The degree of convergence as determined by the amount of contraction of the muscles of the eyes, may also serve as cues in depth perception.

(3) *Binocular Disparity*: The image of an object in both eyes do not fall on absolutely corresponding areas of the two retinae, there being a very slight "disparity" between the two images. The combining of the two images helps to create the perception of depth.

(4) *Motion Parallax*: When the eyes are fixated on an object a slight motion of the head to the right or left makes the retinal images of the nearer objects seem to move in one direction while those of distant objects move in the opposite direction. This enables us to deter-

mine approximately the relative distances of the fixated object from others in the environment.

(5) *Size*: It is easy to determine the distance of an object when its real size is known. The formula $a = \frac{A}{D}$ gives the relationship among the size of the retinal image "a", the real size "A" of the object, and the distance "D" between the object and the eye. It is not to be imagined that every time we look at an object, a conscious calculation of the distance is made using the formula given above. This is a purely automatic process and may even be subconscious. But the retinal image does provide an indication of distance.

6) *Shadows*: The shadow of an object falling on another gives an indication as to their relative distances from the observer. The shading on rounded surfaces gives us a perception of convexity or concavity respectively depending on whether it occurs on the lower half or the upper half of the rounded surface. This is illustrated in the following diagrams:

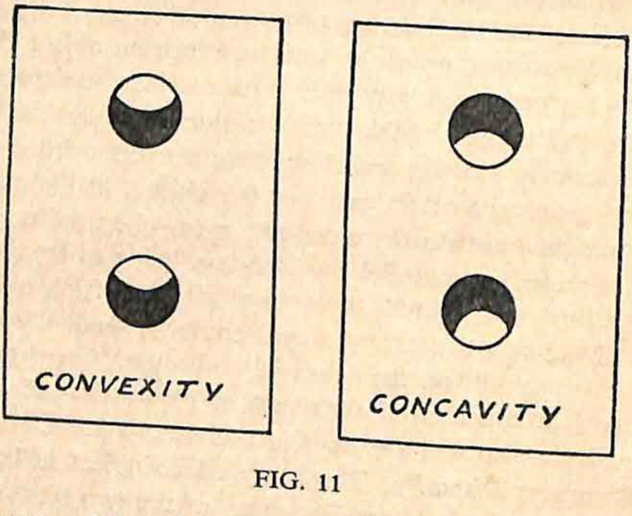


FIG. 11

(7) *Texture*: Gibson has proved by experiments that the texture of the object looked at, creates a gradient stimulating the retina in a particular way and enabling the observer to determine the distance.

Motivational Factors affecting Perception: There is a great deal of truth in the saying that "we see what we want to see". Thus not only do our motives and attitudes predispose us to perceive objects which interest us at a particular moment, but they also may alter the quality of the total percept in a subtle manner. A hungry person, for example, is predisposed to perceive food objects more easily than other things in the environment and at the same time these may even appear more delectable than at other times.

In 1936 Sanford studied the effect of hunger on word associations and on the perception of ambiguous figures by children. He found that just before mealtime the children gave twice as many food-related responses than when they were not hungry and that the number of such responses relating to food increased in direct proportion to the length of time the subjects were deprived of food. This seems to indicate that the actual physiological need of a person may also influence the selectivity of his perception.

Schafer and Murphy (1943) demonstrated that other motives like the desire for reward may also influence perception. Their method was to present four outline faces one at a time on a tachistoscope "rewarding" two of the faces regularly by the payment of a small sum of money and "punishing" the other two by taking away a small sum. The training session consisted of 25 random presentations of each face, care being taken to adjust the rewards and punishments in such a way that the subjects always ended up with a small gain. The final test consisted of the perception of two composite ambiguous figures each made up of a rewarded face and an unrewarded one. The rewarded faces were detected more than four times as frequently as the punished ones thus showing a definite selectivity in favour of the former.

In another experiment Ansbacher (1937) had twenty children—ten of them from wealthy homes and the rest from the slums—alter the size of a circular spot of light on a ground-glass screen to correspond with the estimated sizes of various American coins. This they had to do under two conditions—with the actual coins held in the palms of their hands an equal distance away from their persons, and also without the coins being present. All the children over-estimated the sizes of the coins, this over-estimation being directly proportional to the value of the coins irrespective of their physical sizes. And poor children showed this effect much more than the rich.

Perceptual Defence: It stands to reason that if it is easier to perceive things we wish to see, it is quite possible that it may be difficult to perceive things we do not wish to see. Thus positive motivational states could enhance and facilitate perception while a strong motivation against perception of objects which offend one's ethical values may inhibit their perception. The mechanism responsible for such inhibition is known as perceptual defence, and may operate below the level of conscious awareness.

McGinnies (1949) presented a list of 11 neutral and 7 emotionally-charged words among which were some taboo words also. All these words were presented one at a time on the tachistoscope and the subject had to read them aloud as they appeared on the screen; this had to be done in the presence of two experimenters, one of either sex. Not only was the reaction time noted but the galvanic skin responses (G.S.R.) were also recorded in an attempt to measure the emotional disturbance engendered by each word. McGinnies found that the taboo words took longer to perceive and that the GSR indicated high emotional disturbance even *before* the words were perceived. These results seem to show that there is a subconscious inhibition against the facile perception of objectionable material. However, this experiment has been criticised by Howes and Solomon (1950) on two counts—first that the student-subjects may have consciously inhibited the reporting of the taboo words even though they had perceived them. There is some indication that this is a possibility because the GSR records showed reaction even in the case of such unreported words. Further, the subjects may also have had greater reluctance to speak out the taboo words especially because the experimenters were their teachers. Secondly, the increased recognition-threshold for the taboo words may have been due to lesser familiarity with these words because such words are not frequently used in everyday conversation. On the other hand the introspective reports of the subjects, granting that these were truthful ones, seemed to indicate that subjects reported each word directly on perception. Whatever be the truth or otherwise of these conflicting pieces of evidence, McGinnies's experiment has indicated that there is a possibility that the perception threshold for objectionable material may usually be higher than that for neutral words.

Innate and learned bases of Perception: Recent experimentation has revealed that animals with differing levels of ontogeny and phylogeny may nevertheless show some innate perceptual abilities while certain other aspects of perception are acquired by a prolonged process of learning.

In 1932, Senden made a study of all the published reports on the visual experiences of congenitally blind people whose vision was restored following a surgical operation for removal of cataracts. All these patients could distinguish a figure from its ground quite easily soon after the post-operative removal of bandages. However, their perception of even a simple geometrical figure like a circle or a square was very poor in the beginning. Even after prolonged training such persons were unable to remember the distinguishing characteristics of a simple figure although they could tell the different figures apart when these were presented together. Not only did they take a long time to learn the names of figures and to remember them, they also had to count the corners to tell a triangle from a square. Finally, when they were able to tell all these different figures at a glance, any change in the colour of the figures or of their backgrounds was enough to destroy the percept.

Riesen (1947) produced more evidence in the same field after a series of studies on chimpanzees reared in complete darkness. These animals also showed discrimination between figure and ground but had to learn to distinguish one simple figure from another after a long period of training.

In man and the chimpanzee, the discrimination of simple geometrical figures remains efficient even when there is a reversal of brightness relations between figure and ground showing that these organisms have the ability to generalize. The rat, however, does not show the ability for discrimination after such reversal and its perception of a triangle is disrupted when the figure is rotated through 90°, but chimpanzees as well as two-year-old children can generalize easily although with head rotation.

Taking all the experimental evidence in the field of visual perception into consideration, Hebb (1949) distinguishes three progressive aspects of efficient perception. First of all there is the *primitive unity* by which is meant the innate ability of all organisms to differentiate in an elementary sort of way between figure and ground. In the simplest operation of primitive unity, a homogeneous zone of colour may be the figure surrounded by another colour which may represent the ground. The congenitally-blind person receiving his sight as an adult, the naïve rat, and chimpanzees reared in darkness, all show the ability to distinguish a figure from its ground.

Secondly, there is the *non-sensory figure-ground organization* which is a product of experience. This not only means the ability to differentiate a figure from its ground but also refers to the selective response involved in attending to a limited part of a homogeneous area. Hebb gives as an example, the perception of a small area in a continuous expanse of lawn where the flower-bed is to be put in.

Finally, there is *identity* which relates to the classification of a stimulus figure under a specific category along with other objects having similar characteristics. The perception of similarity to some objects and not to others is a progressively efficient phenomenon in as much as experience with objects improves the degree of success of such categorization. The principle is implicit in the perception of identity that not only is the similar characteristics perceived but also the actual points of difference between a given figure and others in the previous experience of the organism. This means remembering of similar features as well as differences.

Informed opinion at the present time accepts the fact that adult perception of the environment is effected by a combination of innate ability coupled with maturation of the relevant mechanisms and also the cumulative experience built up by a process of learning; and there is reason to believe that innate perceptual ability may have a less important role to play in the perceptual life of at least some of the primates than was hitherto imagined.

CHAPTER FOUR

Memory

Memory can be thought of as the enduring after-effects left by various experiences. Though it is not very clear how this operation takes place, it is accepted that these after-effects are registered in the brain in the form of memory traces. Richard Semon (1904) suggested the name "engrams" and posited a process called engraphic action for their inception. He also postulated another process called ecphory which would be responsible for reactivating the engrams from their latent, unconscious state into a conscious memory. Simultaneously reactivated engrams constitute an engram-complex which is the basis of associative memory and to which engrams relating to new experiences are constantly being added.

Not very long ago, some philosophers likened the mind of a new-born baby to a clean slate on which experiences scratch appropriate marks; the reactivation of these was supposed to reinstate the memory of the original events in some mysterious way. This concept which presupposes that memory traces are an exact copy of the external events responsible for their inception, is not a dynamic view of mental activity and is not borne out by experimental results. Without however bothering about the exact location and the nature of the memory traces, it is possible to discuss the implications of memory. First of all, it is possible that much more is stored in memory than what we are directly aware of. Sir Percy Nunn has suggested the name "mneme" for the entire enduring after-effects of experience. What can be recalled then becomes conscious memory. This distinction is necessary because sometimes hypnosis can help to uncover matters long forgotten and also things not even suspected to exist at all. Not only does the mneme consist of impressions received during the lifetime of an individual but it may also contain some latent impressions going far back in the history of the race transmitted from father to son. If this concept is accepted, it is easy to see why the cultural heritage of any given society grows richer with each passing generation. Jung based his psychological system largely on this concept and named it the archetype or the collective unconscious. Extending this idea it is possible to think that a link exists between the minds of all the individuals in a community, possibly at a subliminal level. In cultures that existed during the first Golden age in history, Babylonia, Greece, India, China and Egypt—despite the obvious difficulties of intercommunication that existed then—similar myths, legends and beliefs existed. This may perhaps be considered as evidence for the continuity of the mneme and for the idea that all human beings must have descended from a common stock.

All these concepts outlined above seem to indicate that it would be a good thing to delineate two aspects of memory—active memory and latent memory. When something is forgotten, it can be termed latent memory, for under this concept forgetting only means that the particular material has gone out of reach of conscious recall but not lost. Active memory can be said to operate when an experience of the past is successfully recalled. Perhaps recognition is a reactivation of latent memory. The following account will make this clear:

If a subject is shown a picture or pattern and later asked to reproduce it, it is more than likely that he would be unable to do so on account of his having forgotten it. However, if he is shown the same picture along with others which he had not seen before, he may be able to choose the correct one without much difficulty. This is possible because the memory of the picture though not in immediate awareness is nevertheless somewhere in the background.

EXPERIMENTS ON MEMORY

Some of the earliest and most celebrated experiments on memory are those of Ebbinghaus who set out to invent some material which would not be fraught with meaning thus leading to differential forgetting. As a result he made up nonsense syllables which would not be coloured by emotional tones. These syllables consisted of three or four letters (usually consonants) as for example JDX, MBT, LRP, VOC, DUX, and JUD. Ebbinghaus laboriously constructed 1200 lists of such syllables each list containing 13 items. He learnt each list by reading through it giving two-fifths of a second to each item and continued till he could repeat the list without mistakes, twice in succession. After a pause of fifteen minutes he dealt with another list in the same way. After 31 days he learned the same lists again and calculated the amount of saving as a percentage. He generally obtained a saving of 20.5 per cent on the original time taken to learn and also noticed that the time of the day affected speed of learning, the early morning hours being the best, and the late evening the worst possible so far as efficiency of retention was concerned. Correcting for all such variables, Ebbinghaus made out a graph plotting the amount of material retained (in terms of percentage) against the number of days. This curve popularly known as the curve of forgetting, was based on the data of only one subject —Ebbinghaus himself. But he was so thorough and conscientious that experimenters to date have found it possible to duplicate his results.

In general, learning experiments make use of a few standard methods of memorization not all of which are equally efficient. In the *method of retained members,* a meaningful passage is presented to the subject for a pre-determined length of time after which written recall is elicited. In scoring, the original passage is divided into a number of equal units and the amount reproduced calculated as a percentage. This method suffers from the obvious disadvantage that much more may have been retained than the actual amount recalled.

In the *learning method,* the time taken for learning to a criterion or the number of trials needed would be recorded. Among the advantages of this method may be mentioned the fact that scoring is done as a whole and that this technique may be applicable to a variety of material. On the other hand there are some very serious objections against the use of this method. For instance, it is often noticed that a subject would learn nearly nine tenths of the material in six trials and would take another six or more trials to master the rest. Thus the effort needed is disproportionately distributed resulting in overlearning of part of the material. Woodworth has introduced a slight variation to this method, which innovation eliminates the fault mentioned above. In this method known as *adjusted learning* as soon as an item has been successfully recalled once, it is removed from the list. This ensures that all the items are learned to the same extent without any overlearning of a few items.

The *Prompting Method* or the *Method of Anticipation*, consists in presenting the material item by item on a memory drum. After the first presentation of the whole series the subject is required to anticipate the following item when the previous one is presented. If he delays or cannot anticipate the next one, the apparatus which is pre-set to present items at a certain speed, "prompts" him by presenting the next item in the viewing window.

In many classical experiments on memory, the Saving Method was used in which the subjects learned a series of items to a specified criterion and then relearned the same items after an interval of time. The saving in time or in the number of trials, is converted into a percentage.

It is an observed fact that although only a few items in a mnemic series can be successfully recalled, more items can be recognised. To give an example, twenty pictures can be presented to a subject for a brief interval. After a few minutes, these twenty pictures can be shuffled with twenty new ones and the whole series presented to the subject for identification of the original pictures. This would be the "Recognition Method".

The *paired-associate method* of presentation first introduced by Mary Calkins, consists in the pairing of two kinds of items. In each pair, the first item is the stimulus and the second one the response. After a few presentations of both items of each pair, subjects have to anticipate the response items when the stimulus ones are presented.

Finally, there is the *reconstruction method*. For instance, a number of picture cards are presented to the subject in a particular order. The cards are then shuffled and handed to him to arrange in the original order. The correct order and the subject's attempt are then compared using a statistical technique.

DISTORTIONS IN MEMORY

Everyone knows that the material recalled by a person is often not an exact copy of the stimulus presented to him during the original learning. For instance, when an accident occurs in the street, many of the bystanders who are near the scene would give conflicting accounts of the incident. Similarly, a story once heard is not repeated in the same way during the retelling. One of the most famous experiments in this field is due to Bartlett (1932) who used two kinds of conditions —one known as *serial reproduction* and the other as *repeated reproduction*.

In serial reproduction, the stimulus story is presented briefly to the first subject whose reproduced version forms the stimulus for the second subject and so on. If a number of subjects are dealt with in this way, the last reproduction would be found to be quite different from the original stimulus material.

The method of repeated reproduction uses only one subject who reproduces the stimulus material after various intervals.

Bartlett used a story called the "War of Ghosts" with which he demonstrated very interesting changes in its retention with the passage of time. Analysing the results of these experiments, he found it possible to abstract certain general directions along which the changes seemed to occur. First of all, he found that a subject did not blindly commit to memory the entire story verbatim but interpreted it according to his own cultural background. Bartlett termed this process the "search after meaning". During reproductions, points in the story which did not conform to the conventions and mores of the subjects' own cultures, tended to be modified. In the War of Ghosts story, the canoes of the Red Indian warriors were changed to 'boats' and the implication of a ghostly war was watered down to a very mundane battle involving absolutely no supernatural elements. A definite trend towards rationalization was also noticed in the reproductions. Moreover the subjects' own immediate and pressing personality needs also determined which parts were successfully retained and which forgotten. Thus subjects who were not quite willing to serve in the army and go abroad for active service reproduced and elaborated the excuses given by one of the Red Indian warriors for not going with the war party.

Further, the order of events also tended to be disturbed, those elements considered very important by the subject coming to be recalled earlier on in the story while insignificant details were relegated to the end. When an introspective report was invited from the subjects, many of them confessed to being uncertain about some points in the story which they substituted by material that, according to them, rightly belonged in the particular context.

All the above observations led to the conclusion that a subject presented with a long stimulus material, remembered clearly only a few "dominant details". When reproducing the material he did not exactly reproduce it but built it anew around the well-remembered details. Bartlett described this process as *Reconstruction* rather than *Reproduction.*

Another type of memorial experiment performed by Bartlett consisted of presenting abstract figures very briefly to subjects and eliciting their reproductions immediately. Suitable controls were provided to offset the vagaries of drawing of individual subjects—those with poor drawing ability being asked to describe it instead. Some of the material used by Bartlett looked like this:

It will be clear from these illustrations that Series A contained

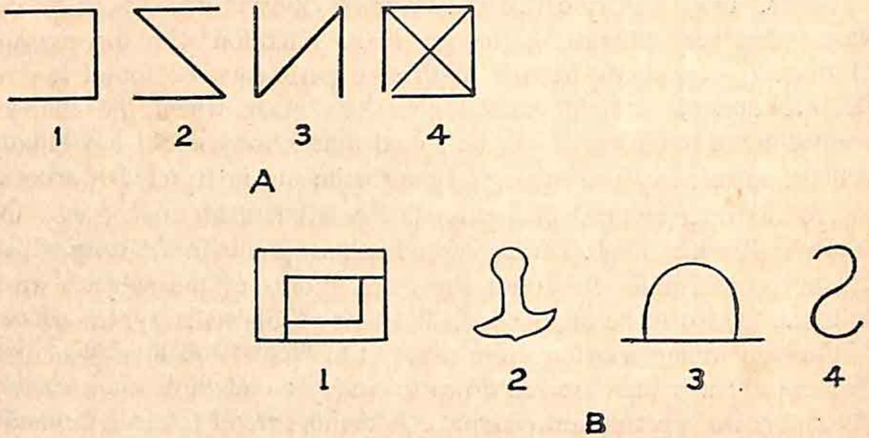
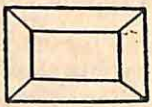


FIG. 12

simple outlines all of which are easy to reproduce provided the subject pays attention to details. However, Figure 4 in this series was found to be the most difficult in that the subjects could not reproduce the incomplete corner accurately. Most subjects compared these figures to familiar shapes which seemed to help in their reproduction. Thus, Figure 1 A was called a square with a side missing, figure 2 A was thought of as Z, and 3 A as N (although subsequently it was correctly reproduced).

Series B was rather different in that the figures lent themselves to labelling depending on the objects which they seemed to resemble. Thus a subject who thought of B-1 as a picture frame reproduced it as:



B-1

FIG. 13

whereas another who thought of it as two carpenter's squares held together, reproduced it correctly.

Some subjects who labelled B-2 as a key tended to reproduce its shape to conform to that object whereas those who thought of it as an anchor reproduced it to look like an anchor. Some others who thought of it as a pick axe made the blades thinner and longer. Figure 3 was reproduced to resemble a hat by those who compared it to that object, and reproduced as a hive by others who thought of it as resembling that object.

A slight variation of the above experiment in which the experimenters supplied the labels, was conducted by Bruner, Buswick and Minturn (1952) who prepared a series of ambiguous figures each of which could easily bear a resemblance to familiar objects. To each of two groups of subjects, the same stimulus figure was presented but with a different label. The reproduced figures were found to conform to the object represented by the label. The results of all these experiments seem to confirm the hypothesis that a "dominant detail" would exert a directive influence on remembering.

Lindgren and Blackburn conducted a series of experiments in the setting of everyday life. After a series of three consecutive meetings of the Cambridge Psychological Society at each of which, unknown to the members, the exact proceedings were recorded verbatim, letters were sent out to those present requesting them to write out what exactly happened at these meetings. When the letters arrived, the experimenters were struck by the extent of the distortions introduced. In addition to pure inventions, the subjects discussed and the trend of the discussion itself were distorted and emphasis shifted. Exaggerations, elaborations and subjective interpretations abounded in these accounts. A very spectacular effect was that of inference. Remarks were ascribed to people merely on the assumption that as they usually adopted a certain attitude in these discussions they might have made particular comments. Ego-centrism was particularly evident, each member ascribing to himself some of the most cogent remarks made during the conference. And a high percentage of one's own remarks were correctly recalled.

In another study by the same experimenters, subjects were asked to describe the room in which the conferences were held. The results, which disclosed a striving after symmetry as also a more pleasing arrangement of the furniture, seemed to support the Gestalt concept of the autonomous tendency for memorial traces to attain goodness (prägnanz).

RETRO-ACTIVE INHIBITION & PRO-ACTIVE INHIBITION

There are two main views regarding the origin of distortions in memory.

According to the Gestalt Theory, memory traces by themselves undergo gradual changes which would make the memorial content to attain prägnanz—a state of goodness. Added to this a certain amount of interaction also takes place among the traces; this operation helps to make the memorial systems more stable. Thus in the Gestalt view interference from other materials learned either before or after the stimulus material constitutes a less important source of distortion than endogenous factors. This point of view will be discussed in detail under theories of forgetting.

The second view about distortions is that they are directly due to other materials learned during the retention interval or even before the original material. These sources of distortion are referred to as retro-active inhibition and pro-active inhibition respectively.

Pro-active Inhibition (*P*.1.): If a subject is given a list of words—A —to learn first and then another list B, it would be expected that in a subsequent test of retention of List B, the words from list A would interfere with those of B. This effect of a previously learned material on the retention of a subsequently learned one, is known as proactive inhibition. An experimental paradigm designed to detect and quantify the amount of P.I. would be something like this:

Experimental group—Learn A—Learn B—Recall B
Control group — Rest —Learn B—Recall B

Comparison of these two groups would disclose the amount of PI generated by the learning of List A prior to the learning of List B. In such an experimental situation as the one outlined above, the group (control) which has no prior learning of another list always performs better than the experimental group indicating that the learning of List A does have an adverse effect on the retention of list B.

Careful investigators, after a number of experiments in this field, have come to the conclusion that in the main there are four variables which may affect the amount of PI generated.

(1) If paired associate learning is adopted in an experimental situation designed to assess the extent of PI, it has been found that the degree of formal or meaningful similarity between the stimulus items in lists A and B would cause a direct increase in pro-active inhibition. This finding has been confirmed, among others, by Blankenship and Whitely, 1941; Melton and Von Lackum 1941 and by Underwood.

1944. Underwood in particular demonstrated that when the stimulus members of lists A and B were dissimilar, PI was only 25 per cent whereas when they were similar PI rose to 51 per cent.

(2) On the other hand, if the stimulus members of both lists are kept identical but the responses are varied in the similarity dimension it has been found by Osgood (1946) that as response similarity increases PI decreases. Morgan and Underwood (1950) using a similar experimental paradigm, have corroborated Osgood's results.

(3) If retention of List B is tested immediately after learning, the PI due to A is less than when retention is tested 48 hours later. This has been confirmed by Underwood (1948).

(4) Pro-active inhibition is also a function of the amount of preliminary learning on List A. As the degree of practice on List A or the number of lists included in A increases, the facility with which list B is learned also seems to increase. But the PI itself seems to depend on the time interval between the learning of B and the test of retention as already mentioned in the previous paragraph.

Retro-active Inhibition (R. I.): Retroactive inhibition is the interference caused by material learned during the retention interval upon the stimulus material. Thus if List A is learned first and if another list B is learned soon after, Retro-active Inhibition is the interference caused by List B on the recall of A.

An experimental design for demonstrating Retroactive inhibition would be as follows:

Experimental group	—Learn list A	—Learn list B	—Recall A
Control group	—Learn list A	—Rest	—Recall A

It is customary that during the rest interval in both RI and PI paradigms the subjects are given some specified activity to perform; this activity being quite dissimilar to the main learning task would not vitiate the results too much either by facilitation or by causing interference. This is considered necessary as otherwise subjects may, during this interval, tend to rehearse the stimulus material.

Retroactive inhibition has been found to be a function of several experimental conditions some of which are described below:

(1) First of all, there is the similarity between the original task and the interpolated one. A well-known hypothesis known as the Skaggs-Robinson hypothesis formulates that "as the similarity between

interpolation and original memorization is reduced from near identity, retention falls away to a minimum and then rises again but with decreasing similarity it never reaches the level obtaining with maximum similarity". This hypothesis is based on the results obtained by Skaggs (1925) and by Robinson (1920).

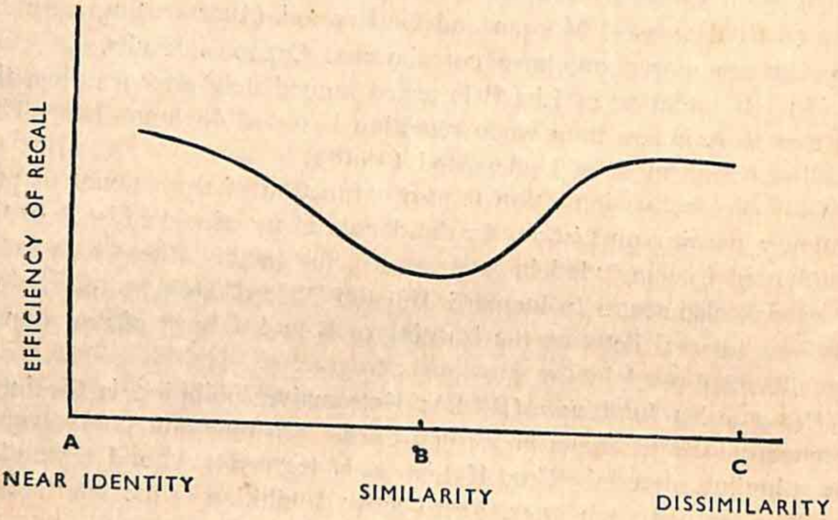


FIG. 14

Since the formulation of the Skaggs-Robinson hypothesis several experimenters attempting to verify it have only succeeded in obtaining partial corroboration. One reason for this failure may have been due to the fact that similarity can be of many different kinds, as of identical elements, of meaning, of task or operation and of similarity of serial position respectively.

(2) It has also been found that the greater the degree of original learning the less the RI obtained. The amount of original material learned or the length of the original list constitutes another variable. It has been found that as the original list increases in length, at first there is a reduction of RI after which longer lists seem to give approximately equal amounts of inhibition.

(3) With a constant degree of original learning, as degree of interpolated learning is increased, at first the RI seems to increase but with high degrees of interpolated learning the RI has a definite tendency to decrease. The amount of interpolated material also has an effect on RI.

its adverse effect being greatest when the IL is exactly equal in amount to the original learning. All these relationships point to the conclusion that RI is greatest when there is the least amount of differentiation between IL and OL and least when the two materials are differentiated quite well.

EFFICIENCY OF RETENTION AND INTERPOLATED INACTIVITY

By now it may have become obvious to the reader that the post-learning interval is crucial in so far as the efficiency of retention is concerned. If this interval could be without any activity till the test of retention, then it is reasonable to assume that the original material may be reproduced without many changes. Such a psychological vacuum, however, is very difficult to achieve, because the remembering organism is alive during the interval and therefore some activity is bound to be present. However, two different methods have been tried to induce inactivity either by the subject going off to sleep immediately after learning or by the administration of depressant drugs soon after acquisition. The first of these methods was tried by Jenkins and Dallenbach (1924) whose subjects had to learn lists of ten nonsense syllables. The experimental subjects learned these lists just before bed-time and went off to sleep immediately; they were awakened after the required interval for the retention tests. The subjects with the interpolated waking activity learned a list and went away to their respective jobs, coming back only for the test of retention after a specified interval. When retention curves were drawn to compare the performances of the two groups, it was found that even for subjects who went off to sleep soon after learning, the retention decreased for the first two hours although the loss was smaller than that for the other group. After this interval the recall efficiency of the waking activity group decreased rapidly while that of the others remained steady.

The result of this experiment seems to indicate the superiority of sleep over other activities in preserving a high efficiency of retention. The initial drop during the first two hours has been explained by some experimenters as being a function of the activities of leaving the experimental room, getting into bed and falling asleep. Van Ormer (1932) using the saving method to assess retention but otherwise following the procedure of Jenkins and Dallenbach, has corroborated these re-

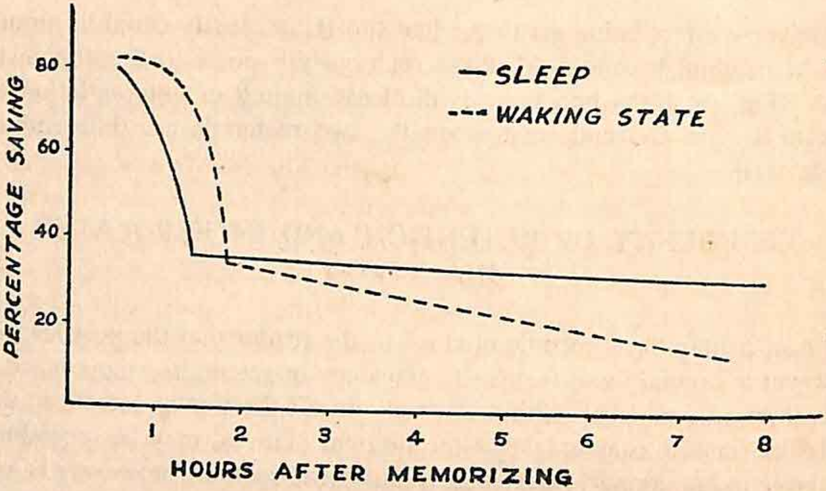


FIG. 15

sults. Minami and Dallenbach (1946) using cockroaches, have demonstrated higher retention of a simple maze habit when the cockroaches spent the retention interval in a state of immobility than when they had some kind of activity.

Summerfield and Steinberg (1957) administered nitrous oxide to subjects soon after learning and found that less forgetting occurred under this condition than when subjects spent the retention interval breathing air. This is because nitrous oxide has been shown to impair the formation of associations. Therefore there would be less chance in this condition for the formation of conflicting associations.

THEORIES OF MEMORY

In modern theorization relating to memorial retention and forgetting three main approaches are distinguishable, the neurological, the informational and the psychological. Though these three have been considered separately here, they are in point of fact not mutually exclusive. The psychological theories in particular are so broad-based and comprehensive as to assimilate techniques as well as information relating to the other two approaches.

Neurological Theories: Though the exact nature of the memory traces is not very clear at the present moment, the consensus of opinion is that memorial traces are confined to the nervous system and specifically to the cerebral cortex. But ever since the discovery that a neurone has no anatomical continuity with another at the synaptic junction but only a functional one, it was realised that the degree of proximity between the elements belonging to two neural cells would determine the facility of conduction of a neural current. The fact that a neural path through which an impulse has already travelled becomes an easier route for subsequent impulses could only mean that a closer synaptic contact had been established. Such closeness of contact can be achieved by the growth of amoeboid structures at the synapses (Tanzi 1893) or neuronic fibrils may grow towards one another as envisaged by Kappers (1929) and Bok (1892). But structural changes take too long to develop and so cannot explain many facts of memory. Nor can they explain how memories can become suspended during sleep and yet become conscious on awakening. However, Duval (1895) held that in sleep and other unconscious states, the terminal branches of the neurones contract enough to prevent the passage of impulses from one neurone to the next.

Another theory which got away from the concept of neuronal growths was that of Ribot (1881) who held that neural conduction results in the rearrangement of molecules within the cell; repetition of the stimulus has the effect of preventing the molecules from attaining their original state. Ludwic Monné (1947) thought of neuronal activity in terms of rapid protein synthesis within the cytoplasmic fibrils. According to him, memory must be associated with some permanent changes of the cytoplasm. A mathematically-derived theory based on the quantum theory of physics is due to Forster (1948) who postulated that memorial traces are borne by large and complicated protein molecule-complexes in the cortical cells. The traces themselves are gradually built up by raising the energy levels of these molecules by steps (quanta). Forgetting according to this concept would consist in the reduction of energy levels.

Most of the theories referred to above were based on the concept of the linear conduction of neural impulses. In 1934, Lorente de Nó discovered the existence of closed chains of neurones; this finding made it possible to think that an impulse once set up in one of these chains can continue to circulate without assistance from new afferent impulses. Rashevsky (1938) envisaged such neuronal reverberatory circuits as the basis for a mechanism of learning which need not involve permanent physico-chemical changes in the neurones. Hebb (1949) postulated another type of closed system which he called the Cell Assembly which is envisaged as a diffuse structure comprising cells in the cortical and sub-cortical centres. A cell assembly is thought of as linking itself with others of its kind and can be stimulated by another system of the same kind or by sensory stimulation or by the combined effects of both. Adrian (1947) and later Eccles (1953) have postulated a link between a reverberatory concept of immediate memory and a permanent neuronic change concept of long-term memory; under this concept it is possible to think of the reverberatory circuits as maintaining short-term memorial retention till some kind of permanent structural changes take place at the synapses. Some empirical corroboration for these concepts has been provided quite recently by Burns (1958).

But at the present moment neurological theories are not able to account for the distortions in memory, for the existence of the serial order effect and for the systematic confusion occurring among items especially in immediate recall.

THE INFORMATIONAL APPROACH

The basic concept of the information theory is that the amount of information specified by any item increases as a function of the number of alternatives among which it has to be identified. In mathematical terms, the amount of information such an item possesses is a logarithmic function of the number of possible alternatives. Information is usually quantified in "bits" the number of bits of information pertaining to a specific item being determined by the number of items in that class from which it is drawn. On this assumption, the number 5 would specify less information than 55 because the former is drawn from a class of only 10 whereas the latter belongs to a class of 100 items. Miller (1950) has suggested that the larger a class of items is numerically, the less likely would a person be able to store and reproduce items from that class.

If memorial material is very efficiently organized, much more material can be remembered than when the organization is haphazard. Efficient means of encoding mnemonic material is another way of reducing the informational content present in it. Under certain conditions it may be possible to vary the length of a list of mnemic material independently of the amount of information in the list as a whole, as was demonstrated by Aborn and Rubenstein (1952). There has also been some evidence (Pollack, 1953) in support of the view that the extent of memorial loss at the time of recall depends directly on the length of the list rather than on the total informational content or on the information per item. Miller (1956) has demonstrated that the immediate memory span for most mnemic materials may be 7 irrespective of the informational content per item. If this is indeed true, then by adopting a very efficient system of encoding, it may be possible to cram a large quantity of information into the memory span.

THE PSYCHOLOGICAL THEORIES

(1) *The Perseveration Theory*: This theory due to Miller and Pilzecker (1900) postulates that the neural activity initiated by learning may persist for some time even after the cessation of formal practice, this continuing activity causing the neural pattern to "set". The exact nature of the perseveration is not very clear. Some theorists think of it as a kind of inertia phenomenon possibly a bio-chemical lag; others explain it in terms of reverberating neural circuits on the lines envisaged by Lorente de Nó (1934). However, the implication of the perseveration theory seems to be quite clear. Any activity immediately following learning should have the greatest adverse effect on perseveration resulting in impaired retention and this effect should diminish in strength the farther away in time the interpolation is introduced in the post-learning interval.

A number of psychological phenomena like the performance of repetitive acts (stereotypy) by some adults and children, the running of tunes in one's head, memory after images, and the occurrence of retrograde amnesia all seem to support the concept of perseverating neural activity. The results obtained by Jenkins and Dallenbach (1924) and by Spight (1928) on the facilitatory effect of sleep immediately after learning also seem to suggest the operation of some kind of consolidatory process. Strong support for this theory has been provided by Duncan (1949) who administered electric shocks to rats after various post-learning intervals from 20 seconds to 14 hrs.

The rats in this experiment had to learn a simple discrimination habit. Duncan found that when the shock came within a post-learning interval of 20 seconds, no appreciable learning took place. It would appear from Duncan's experiments that the greater the degree of closeness of the shock to learning the greater the detrimental effects upon retention. Human patients suffering from retrograde amnesia as a result of either brain injury or electro-convulsive shock therapy, also show effects similar to those observed in Duncan's animal subjects. A word of explanation must be given here about Retrograde Amnesia. When a human being receives an injury to the head which renders him unconscious, he would not be able, on awakening, to remember anything which happened at the time the accident occurred. Not only that, it is usually found that he would have forgotten the events which happened a short time (15 mts. or so) *before* the accident. This phenomenon is known as retrograde amnesia. Indirect evidence in support of the perseveration theory was provided by Summerfield and Steinberg (1957) who administered nitrous oxide to subjects immediately after learning thus preventing the learning of any other associations during the retention interval. This procedure may have helped to consolidate the traces of the original learning.

However, there are a number of experimental findings which seem to argue against an unconditional acceptance of this theory. For instance, even though perseveration effects have been posited to last only for a few minutes, retention decrements have been demonstrated by Bunch and McTeer (1932) when activity was interpolated midway in a six week post-learning interval. Secondly, when a long list of words is learned, the perseveration theory would predict that the last item should be the best retained and the first one least because each succeeding portion of the material should damp the perseveration of the preceding ones. The usual serial position effect obtained under such circumstances do not conform to these predictions; the middle portion of a long list is less well retained than either the first or the last.

Finally, another factor implied by the perseveration theory is that the degree of similarity should have no effect in determining the amount of memorial loss. However, Osgood (1953) and McGeoch (1952) have demonstrated such a relationship.

The present status of this theory is hard to assess. If one-trial learning can be demonstrated in a variety of learning tasks, a revival of the perseveration theory seems a likely development. As matters stand at present, it can only have a very limited application in a restricted field of learning situations.

(2) *The Rehearsal Theory*: In opposition to the Perseveration Theory which considers interpolation inimical to efficient retention, is a hypothesis which states that effective consolidation of memorial traces

may be a function of the amount of rehearsal which takes place during the retention interval. This theory implies that the decremental effects of interpolation are primarily due to the prevention of effective rehearsal of the critical material, this resulting in the decay of memorial traces.

But a large volume of experimental evidence has been quoted against it. For instance, in the experiments of Jenkins and Dallenbach (1924) and Spight (1928) rehearsal could not have been possible because the subject went off to sleep immediately after learning and yet retention was found to be better than in a waking condition. Further, Ward (1937) and Hovland (1938 & 1940) found that various types of interpolated activity facilitated memorial retention. Again, in the case of perceptual motor activities like performance on the pursuit rotor in which symbolic rehearsal is impossible because of the paucity of any symbols which lend themselves to rehearsal, retention has been found to be very good even after long intervals. Finally, Rohrer (1949) seems to have demonstrated that deliberate instructions by the experimenter asking the subjects to rehearse during the retention interval in a rote-learning situation did not result in facilitation of performance.

However, John Brown (1955) working in the field of immediate memory, has provided some evidence to support a rehearsal theory. He demonstrated that if interpolated material served only to prevent rehearsal, the similarity or dissimilarity of such material to the original learning task should in no way affect retention. Whatever be the nature of the material interpolated, provided it prevented rehearsal the resulting decrement of retention should be the same. Moreover, any material presented before (the PI condition) the critical material should have no effect on retention of the latter because it cannot prevent rehearsal. This also Brown seems to have demonstrated. Conrad (1957) and Broadbent (1956)—other experimenters in the field of immediate memory—using digit materials, also have provided results which seem to support a rehearsal theory.

(3) *The Schemata Theory*: The schema theory first formulated by Henry Head (1861-1940) was developed in connection with the problem of postural recognition; the schema was interpreted as a standard against which bodily movements were gauged. Bartlett (1932) adapted the schema to the particular needs of memorial retention after making a number of changes. He envisaged the functional division of the schema into a number of relatively autonomous schemata which may interact among themselves.

The schemata theory takes into account the effect of past experiences and delineates present perception as a dynamic process of interpretation during which the schema already present influences the current percept and is, in turn, modified by it. Thus recall may not be a faithful copy of the original stimulation but may consist of reconstruction based on a few well-remembered details.

In the perception of non-verbal materials like abstract figures for instance, conventionalization may consist in labelling the figure in terms of a known object and relying on this verbal label for producing the original figure at the time of recall. In cases where such a close correspondence to a familiar object is not possible, subjects may resort to a device which Woodworth has succinctly described as "schema with a correction", that is the subject may think of the figure as a specific known object with certain differences.

While it is largely true that past experience plays an important role not only in current perception but also in mnemic retention and reproduction, the Schemata theory as it stands at present cannot be said to be able to explain some facts of memory. For one thing, its implied denial of the discrete existence of individual memories makes it difficult to understand how in actual practice, individual memories especially those relating to childhood, can sometimes be revived under hypnosis and psychoanalysis. If the schemata theory as postulated by Bartlett is a fair representation of memorial processes, the older a memorial element is the closer-knit it would be in a coherent system of other elements and would therefore not be amenable to disparate reinstatement.

(4) *The Gestalt Theory*: The gestalt theory (Koffka, 1935; Köhler 1938; Katona, 1940) envisages the continuing activity of memorial trace systems during the retention interval resulting in distortions which appear when retention is being tested. The causal factors for these may be endogenous changes occurring in the traces or interaction among the various systems or usually both taking place simultaneously. This theory does not hold with the concept of a passive decay of traces and postulates instead another of dynamic interaction. Autonomous changes observed have been delineated under three heads:

1. Closure, the tendency to obtain completion, 2. progression towards enhanced symmetry and 3. A general change towards the attainment of goodness (Prägnanz). In 1922, Wulf carried out a number of experiments using different patterns of lines as the stimulus material

and demonstrated three types of autonomous trends, viz., (a) normalization, the gradual approach of the figure remembered towards the shape of known objects, (b) Levelling, the loss of certain outstanding characteristics, and (c) Sharpening, the accentuation of certain other details.

Among the earliest of experiments performed to verify Wulf's hypothesis was an investigation by Allport (1930) who claimed to have found a definite progression from asymmetry to symmetry in the reproduction of figures by 350 schoolchildren, but none in the opposite direction. M. B. Hubbell (1940) demonstrated that closed symmetrical figures showed no changes even after a long retention interval whereas asymmetrical, open figures showed progression towards greater symmetry. A logical implication of Hubbell's finding is that symmetrical figures may be better retained than asymmetrical ones. Fred Attneave (1955) demonstrated such a trend in the retention of a uniform pattern of dots using a paired associate experimental paradigm. However, on quantifying the informational content of the asymmetrical figures, he found that these contained more information than symmetrical ones containing the same number of dots. Therefore in remembering an asymmetrical pattern more information has to be retained.

The evidence against autonomous changes is equally imposing as the evidence for it. J. J. Gibson (1929) presented a number of figures in quick succession asking for reproduction at the end of the series. He found some evidence for object-assimilation (conventionalization in Bartlett's terminology and normalization in Wulf's) but more than half the figures showed no definite changes at all. Woodworth (1938) analysing the examples of successive reproduction of figures published by Wulf, found no evidence for progressive changes on the scale envisaged by the latter. Hanawalt (1937) got a few subjects merely to copy a given figure and found the same type of changes as were observed in Wulf's "figures"; this seems to indicate that many of the changes caused in reproduction may have been the result of the poor drawing abilities of the subjects. Moreover, the elicitation of successive reproductions may have caused a subject to base his later reproductions on the first. Later experimenters, Irwin and Seidenfeld (1937), Hebb and Foord (1945) and George (1952) all avoided the flaws in design inherent in the earlier experiments and substituted recognition instead of reproduction. They failed to obtain corroboratory evidence in support of endogenous changes in memorial traces.

As will be seen from the results of the experiments described above, there is equally good evidence for and against autonomous activity of memorial systems and therefore we must conclude that the matter cannot be closed one way or the other. But the large quantity of experimental work in this field has probably demonstrated one thing—that traces do undergo changes; but whether these changes are perceptual or continue during the retention interval has not been proved conclusively.

(5) *The Psychoanalytical Theory of Forgetting*: The psychoanalytical theory postulates that forgetting is due to repression of ideas not in conformity with the standards adopted by the Ego; therefore this objectionable material lodges itself in the Id whence it exercises its effect on consciousness through dreams and other manifestations. It is thus obvious that emotionally-toned material capable of producing anxiety is the one which can easily be forgotten; innocuous material which may have been associated with anxiety-producing words also become liable to be repressed. If these premises are true it should be possible to demonstrate the poor retention of hitherto innocuous material following experimental induction of anxiety and the recovery of the original memory following the removal of anxiety. Sharp (1938) using emotionally unacceptable words drawn from the case histories of neurotic subjects demonstrated the poorer retention of such words over those which express gratification. Keet (1948) demonstrated striking results first by causing an objectionable word embedded in a list of neutral words to be repressed and then by suitable counselling procedures bringing the word back into awareness. The causation and later removal of repression have also been demonstrated by Sears (1936, 1937), Zeller (1950) and Aborn (1953) respectively using slightly differing experimental designs.

Another implication of the psychoanalytical theory is that it is quite possible that emotionally-toned words will have their recognition threshold raised. McGinnies (1949) in an attempt to demonstrate the existence of "perceptual defence" carried out a number of experiments with taboo words. These experiments have been criticized on a number of counts which include suggestions that taboo words have less association value on account of their rarity in everyday speech and that therefore their recognition in a brief presentation may have been more difficult. In a recent experiment, Deese (1959) sought to demonstrate that the items which are omitted during recall would be those which have low probabilities of being elicited by remembered items from the mnemic list. Underwood (1957) also holds a similar view that previously learned habits (association between words) have an influence on retention. Another experiment by Levine and Murphy (1943) is of direct relevance in this context. To a group of undergraduates—roughly half of whom were pro-communist and the rest anti-communist, the experimenters read out two paragraphs one of which was sympathetic to communist ideology and the other inimical to that cause. According to expectations the pro-communist students retained the passage which was sympathetic to communism and vice versa. Deese however suggests that this differential retention shown by the two groups may have been due to the differences in association frequencies for critical words between the groups.

To sum up, it seems quite possible that repression may be responsible for many of the failures in recall; and deliberate induction of repression has been demonstrated under experimental conditions. It would seem then that as the memory of each individual experience is sometimes capable of being reinstated, some sort of discrete existence of the traces relating to various memorial items has to be postulated.

(6) *Forgetting due to Altered Stimulating Conditions*: The stimulus situation at the time of recall may differ from that during the original learning in that the eliciting stimuli may be incomplete or new stimuli may be introduced which later are capable of evoking competing responses; these altered stimulating conditions may therefore be responsible for the forgetting that occurs. It is obvious that the exact duplication of a stimulus situation may be difficult not only on account of the large number of environmental stimuli involved but also because there are a number of interoceptive stimuli to be accounted for.

Yum (1931) found that in the retention of nonsense syllables using the paired-associate design, single letter alterations in the stimulus member caused appreciable amounts of retention decrements. Carr (1917) found that altered environments in which rats learned mazes resulted in depressed performance and Pan (1926) using human subjects demonstrated the impairment of recall due the introduction of an extraneous word in the recall situation. Other experimenters have shown that retention decrements occur when different coloured backgrounds were used for learning and recall respectively (Dulsky, 1935), when there is an audience present only during recall (Burri, 1931), and when the method of presentation is changed from one modality to another (Reed, 1931). There is also some evidence that change of rooms and experimenters may affect recall (Abernathy, 1940). (Carr 1925) quotes the story of an Englishman whose fluent command of the Chinese language underwent considerable impairment on a brief visit to England but recovered the old level of proficiency on his return to China. In one of Bugelski's experiments (1956) students, who learned 12 nonsense syllables to a criterion of two successive correct recitations, were unable to recall even a single syllable six months later but showed some retention when the original conditions of experiment like the memory drum were reinstated.

Naage (1935) employed hypnosis and waking for the learning of the original and interpolated tasks respectively and found that retention was very good when recall was elicited under the same physiological condition as during the original learning. The results of some recent studies in immediate memory (eg., Kay and Skemp, 1956) seem to indicate that maintenance of similar stimulating conditions may also be an important factor in enhancing performance during retention.

(7) *Inadequate Set*: Set is defined as certain spatial and temporal orientations which the subject has to adopt at the time of recall to facilitate performance. According to Ammons (1947) and Irion (1948) the failure of recall may be due to the loss of set during the retention interval and inadequate reinstatement of it at the time of recall, the implication being that if the original set could be reinstated at the time of the retention test, there should be very little decrement or none at all. The experiments of Irion (1948), Thune (1950) and Hamilton (1950) have all demonstrated that a brief period of warming-up activity just before recall improves performance. Colour-naming and digit-naming are two activities which have been found to be very effective as warming-up activities. The amount of practice on a warm-up task prior to recall, the similarity of such a task to the original learning and its temporal proximity to the test of retention are other factors which may be expected to have an effect on final performance. Irion (1949) estimates that 87% of the forgetting which occurs in paired associate learning in a 24-hour retention interval may be eliminated by a single pre-recall colour-naming trial.

Ian Hunter (1955) used a novel procedure to demonstrate the facilitation produced by a warm-up task. The original task in this experiment consisted in the subjects' writing out as many names beginning with a particular letter as they could within a time limit of 3 minutes. The warm-up task as also the final one consisted of writing names beginning with other letters. Adequate controls were incorporated to compensate for the fact that the number of names starting with each letter may not be the same. When the warm-up trials came immediately before the final task, facilitatory effects were observed but when this interval was lengthened from 1 minute to 20 minutes no facilitation was obtained.

The implications of the warm-up hypothesis are not very clear at the present time. If warming-up activities could diminish so drastically the recall decrements, it is hard to see what part RI plays in he opposite direction. However, it is possible that in everyday remembering we do not have formally interfering material interpolated prior to recall and therefore RI does not act in quite the same way as it does in laboratory experiments. The other alternative would be to think of loss in set as being responsible for most of the observed cases of forgetting.

(8) *The Two-Factor Theory*: In an experiment to ascertain the relationship between the amount of RI produced and the degree of learning of an interpolated list, Melton and Irwin (1940, 1941) found that although the RI attributable to overt intrusions of wrong responses in recall fell to a low level, the total RI observed remained rather high. To account for the residual RI not directly attributable to overt intrusions, Melton proposed an unlearning factor which he explained in terms of experimental extinction under the conditioning paradigm. According to this, during the learning of the interpolated task, if the responses belonging to the original list appear they would be recognized as intrusions and therefore unlearned thus making them unavailable during a subsequent recall test. This is similar to experimental extinction of a non-reinforced response during conditioning.

The two-factor theory is able to explain the experimentally observed fact that RI is greater than PI because this theory implies that whereas original learning is subjected both to a process of un-learning during interpolation and competition-among-responses during recall, the interpolated learning is subject only to competition. Melton and Von Lackum (1941) and McGeoch and Underwood (1943) have verified this part of the hypothesis. Underwood (1948) also found that the disparity between the amount of RI and PI was maximum at about 5 hours after original learning after which it declined steadily. Underwood has explained the reduction of RI after the longer interval as being due to spontaneous recovery, a phenomenon associated with experimental extinction.

(9) *The Competition-between Responses Theory*: One of the strongest exponents of the current form of the Response Competition Theory is McGeoch (1936, 1942) who advances the view that RI obtained during recall of the stimulus material is mainly due to the competition existing between the response systems of the original learning and those acquired during interpolation. McGeoch (1935) demonstrated the possibility of three kinds of response errors contributing towards the total RI. First, there is the large number of overt intrusions from the interpolated learning accepted by the subject as corect; then there are wrong responses made first and then corrected; and finally there may be some wrong responses rising into awareness but being inhibited because the subject recognises them as being wrong. The last of these categories cannot be directly observed but is based on introspective reports obtained from the subjects. It may be inferred from these findings that competition among responses may also be implicit, in which case it is customary to speak of a negative transfer effect without overt intrusions.

If intrusions take place from interpolated learning to the original one, it is only reasonable to assume that the degree of similarity between the two kinds of learning material should have some effect on the extent of inter-material interference. The Skaggs-Robinson (1927) hypothesis attempted to formulate a clear relationship between similarity of the two learning materials and the degree of interference caused. But a better hypothesis which takes into account stimulus and response similarities is due to Osgood (1949). According to this, maximum facilitation would occur only when the stimuli and responses are identical in both IL and OL. With identity of stimulus members but with varying degrees of response dissimilarity, facilitation gives way to inhibition which attains maximal strength as direct antagonism between responses is approached. With identical responses, a decrease in stimulus similarity causes a falling off of the facilitatory effect towards zero and with dissimilar or opposed responses, decreases in stimulus similarity would result in a reduction of inhibition towards zero. Most of these postulates have been experimentally verified by subsequent experimenters.

E. J. Gibson (1940) attempted to interpret competition between responses in terms of the principles of conditioning and postulated that the tendency for stimulus items to generalize with one another lowers discriminability at the same time causing intrusions. The generalization is held to occur not only among the items of the same list but also between items of OL and IL.

(OL = original learning; IL = interpolated learning)

THE SPAN OF MEMORY

The concept of the Span was first introduced by Jacobs (1887) who defined it as the number of items in a list which can be repeated in the same order after a single presentation. Subsequent experimenters trying to assess its value have found that the span is not a constant value but is a function, among others, of the age of the subject, the character of the items presented, the method of measurement and the degree of organization involved. The method of ascertaining the span is quite simple. Take for example the span for digits. The experimenter prepares a number of lists which vary in length from two or three digits to ten digits.

Example:		
	251	(three digits)
	597062	(Six digits)
	73960426	(eight digits)

It is sometimes necessary to have three or four lists of each length. Starting with the shortest list the experimenter reads the digits at the rate of a digit a second and immediately after, the subject attempts to repeat them in the same order. The experimenter then repeats the same procedure with the next list. The process is repeated using longer and longer lists till at last the subject starts making mistakes. The longest length of list which the subject is able to repeat without mistakes in the same order, is his span for digits. Guilford and Dallenbach (1925) determined the span for digits as being between 6 and 8, the highest for any type of material. Similar figures have been obtained by Terman (1916) and Terman and Merrill (1937). The span for nonsense syllables was found to be about 7 by Ebbinghaus although Brenner (1940) obtained a much lower figure.

The span for some materials based on the performance of university students, is given below:

Pairs of common words	3.0
Nonsense syllables	3.0
Short sentences	3.0
Common nouns	6.0

Simple geometrical figures	6.0
Consonants	7.5
Coloured cards	7.5
Digits	8.5

One of the recent theories which effectively explains the memory span is due to J. Brown (1955) whose rehearsal theory postulates that the memorial traces, established by learning, decay rapidly soon after their inception and can be restored only by rehearsal. Though a certain amount of decay is compatible with accurate recall because of the redundancy usually present in mnemic materials, there is a limit to the extent of decay which can be permitted consonant with efficient recall. When a number of items are presented successively, the trace of the last item would be the clearest in memory while that of the first would have undergone some amount of decay but it can be re-established by rehearsal. Thus the optimum length of list which allows each item to be rehearsed before its memorial traces have undergone too much of decay, is the memory span.

In informational terms, Broadbent (1956) has postulated two systems relating to memorial retention, the P-system (perceptual) and the s-system (storage) respectively. In an efficient mnemic operation, the input is straightaway processed by the p-system allowing only the excess to pass into storage. There are temporal limits to the storage of information and delay beyond these points may cause the particular item in storage to disappear altogether from the system. However, stored items could be re-circulated provided there is enough time left for this after the processing of the other items in the p-system. Thus span in informational terms (Broadbent) is the maximum amount of material which can be passed through the p-system without allowing the earlier items, which had already gone into storage, from disappearing altogether.

CHAPTER FIVE

Intelligence

INTELLIGENCE was defined by Alfred Binet (1890) as "purposive direction, active adaptation and conscious correction". While it may be quite possible to improve on this description, no useful purpose will be served by multiplying definitions. What is required is a thorough knowledge of how intelligence operates and this can best be done by tracing the growth of this concept from the time when people began to think that perhaps the science of the mind could be objectively studied without recourse to metaphysical subjectivity. Scientific attempts to measure intelligence date back to the close of the eighteenth century when phrenologists sprang up like mushrooms. Among them, Gall and Spurzheim measured the dimensions of various parts of the skull and tried to relate these measurements to the various mental attributes possessed by an individual. Bumps on the head were supposed to have definite significance, the idea being that in those places there might have been excessive development of the brain with the consequence that the cranium had to bulge outwards. By and by phrenology came also to be known as the "Bump Theory". A logical development from this was the study of physiognomy in general, initiated by Lavater. The expression on a person's face was made use of in classifying him into a particular mental type. This was very much like the classification of human beings into four groups according to their gait, physical characteristics and facial expression as was done by the Hindu sages of old. Again it was found that while it may be true to some extent that certain traits of character may go with some physical characteristics, their positive correlation to each other could not be said to be infallible.

Carl Lombroso working with habitual criminal types noticed that almost all of them had some physical deformity or other and he believed that a very pronounced deformity always went with a vicious trait. For instance, many murderers were found to have crooked fingers slightly bent towards the palm as in the claws of an animal. Lombroso, on the basis of these observations, advanced his theory of stigmata according to which the proportion of animal (undesirable) nature present in a man was considered directly proportional to the degree of stigmata found on his body. The greater the stigmata, the lower the intelligence of the individual. But evidence in refutation of this theory is quite easy to come by; one has only to cast about among one's acquaintances and friends when it would become clear that very often some people with the most horrible congenital deformities may possess a brilliant intellect.

TESTS OF INTELLIGENCE

Sir Francis Galton, one of the most brilliant of British amateurs in the field of psychology discovered that Fellows of the Royal Society were capable of very fine sensory discrimination. On the basis of this discovery Galton proposed sensory tests as a measure of intelligence. Subsequently it was found that some African tribesmen possessed far greater keenness of sensory sensitiveness than even the Fellows of the Royal Society! Many other fine tests like visual discrimination of brightness, the ergograph tests for endurance and the power of one's grip on the dynamometer all failed to give a satisfactory yardstick with which to measure intelligence.

Finally it was Alfred Binet a French Psychologist who evolved tolerably good tests of intelligence. He was given the task of discriminating between children who were really deficient in intelligence and those who were only lazy. He made up a set of questions for children of a certain age-group and ascertained which questions out of the list could be answered by the largest number of them, mainly on the assumption that the largest proportion of any population would belong to the "average" category in intellectual abilities. By laborious testing of many hundreds of subjects, Binet had tests for children from the age of 4 months to that of 14 years. But he did not make tests for every year for he believed that the greatest changes in intelligence took place only during certain years and not in others. Further, he designed also a few tests for adults. To him we owe the concept of mental age which is the level of intellectual growth of a child irrespective of its chronological age. For instance if a child of 8 can do all the tests meant for the 10-year-olds, then his mental age (MA) is 10. If he can only do the tests for the 6 year-olds then his mental age is 6. However, if he can perform successfully on all the tests meant for children aged 6 and also some of the tests intended for 7 and 8 year-olds, his score in terms of MA will be more than 6 depending on the proportion of the tests for the higher age groups that he is able to perform correctly. There is also another important concept, the Intelligence Quotient (IQ) which is attributed to Stern and Terman. The IQ is calculated from the formula:

$$\mathrm{IQ} = \frac{MA \times 100}{CA}$$

where *CA* is the chronological age of the individual.

Many of Binet's tests have been modified almost beyond recognition, but they provided the first workable basis for the testing of intelligence and therefore represent an important milestone in the history of psychology. Some examples of the Binet tests are given below:

Age Group	*Specimen items used in test*
4 months	Sit up, back supported for 30 seconds.
6 months	Reach for a bright object dangled in front.
12 months	Imitate tester who performs a simple operation like rattling a trinket.
2 years	Remove the wrapper before eating a candy.
2½ years	Name 4 out of 5 familiar objects shown.
3 years	String beads—4 beads to be strung in 2 minutes.
6 years	Find omissions in pictures of human beings. 3 correct responses are needed to pass this test.
9 years	Telling how coal and wood are alike.
12 years	Interpretation of a picture showing an incident.
Adults	Adults had 4 levels. Definitions of 20, 23, 26 and 30 words respectively out of a graded list of 45 words.

Binet's tests however have been criticised on a number of points, the most important of which is that the tests lack universal application, these having been first designed to be used on the street urchins of Paris. And those children cannot obviously be considered to be representative of the general population. Secondly, the Binet tests were of the all-on-none variety, that is unless a child had all the items correct in a particular test, he was not considered to have passed it; this seems to be unnecessarily rigorous and unreasonable. Then again the tests do not seem to have been properly graded. For instance, the same amount of retardation discovered at 8 years of age, would be far less serious than at 5 years. No provisions were made to compensate for this. Finally there were many "catch" questions which would not be allowed in modern testing. Though many of the criticisms levelled at the Binet tests were well-founded and reasonable, it has to be borne in mind that subsequent testers found it easier because they had some kind of specific foundation to build upon.

In Britain, Dr. Cyril Burt standardised intelligence tests for British children and in America, Professor Lewis Terman undertook ambitious revisions of the Binet tests which have now come to be known as the Stanford Revisions. These consisted of 90 tests altogether consisting of 6 for each year from 3 to 10 years of age, 8 tests for the 12th year, 6 for the 14th year, 6 for the average adult, 6 for superior adults and 16 alternative tests. Terman also introduced vocabulary tests. Finally Spearman made an original contribution to intelligence testing by making the tests more comprehensive and also covering many more aspects of a person's abilities as the following examples will show:

Analogies	Black is to white as big is to ...
Synonyms	Ill means the same as ...
Antonyms	Good is the opposite of ...
Mixed sentences	Through air fly the birds.
Classification	Which is the odd-man-out in the following—chair, table, wheat, rug, curtain?
Number series	1, 3, 5, 7, 9 ...
Codes	A message to be transcribed according to a given principle.
Inference	Jack is taller than Bill but not so tall as Tom. Who is the tallest?

Though Spearman's approach was more mathematical when compared to Binet's problem-solving attitude, both these tests gave a high degree of correlation.

Most of the tests referred to above make use of some form of verbal problems which make it conditional that the subject tested must have a minimum knowledge of the three R's. This was not a satisfactory state of affairs because a fair percentage of the population has only a rudimentary education. Besides non-English-speaking people could not be tested at all. To remedy this lack, several types of non-verbal tests have since been designed.

Of these, Sleight's non-verbal tests relate to children between the ages of 6 and 10 and these consist entirely of pictures. To give an instance; making use of the same principle as in Spearman's classification test, a series of pictures, all except one showing some common characteristic, would be shown and the subject required to encircle the picture which does not belong to the series. This test may be as effective as the corresponding verbal test.

Leiter introduced matching tests, 2 for the age group 5-10, and one test each for ages 11-16. In these tests, two sets of patterns have to be matched, the principle involved in the matching to be discovered by the child himself. This test is very important because concept-formation is also involved in it.

A development from the Leiter Test introduced by Penrose and Raven is known as the matrices test and is a purely non-verbal one used originally for the selection and the testing of recruits in the three services during the Second World War. In this test, a set of patterns has one piece missing; the task of the subject is to select a piece from a number of choice figures to match the pattern. This test is now used as a performance test and is usually used with deaf children, illiterates and people who have no knowledge of English.

Besides the non-verbal tests described above, there are some very specialized tests like the object-sorting test devised by Goldstein and Scheerer and the Hanfmann-Kasannin tests. In the object-sorting test, a number of dissimilar objects are given to the subject to be sorted into different categories on the instructions of the experimenter. Hanfmann and Kasannin used wooden blocks of different shapes, colours heights and top surface areas. These have to be classified according to a particular concept to be discovered by the subject. The two tests described above are usually given to subjects suffering from some brain damage or a particular type of mental illness and are supposed to test the subjects' abstractive ability as well as his concept formation.

Other well-known non-verbal tests include the Pintner and Paterson performance tests. Healy's form board test, the army B test and the Minnesota battery of tests, the last of these being for mechanical ability.

In addition there are various specialized forms of tests for superior adults and children. Some of the well-known ones are:

(a) Dr. Ballard's Chelsea and Crichton tests
(b) Professor Godfrey Thomson's 'Northumberland' tests
(c) Thorndike's CAVD (Completion, Arithmetic, Vocabulary; Direction)

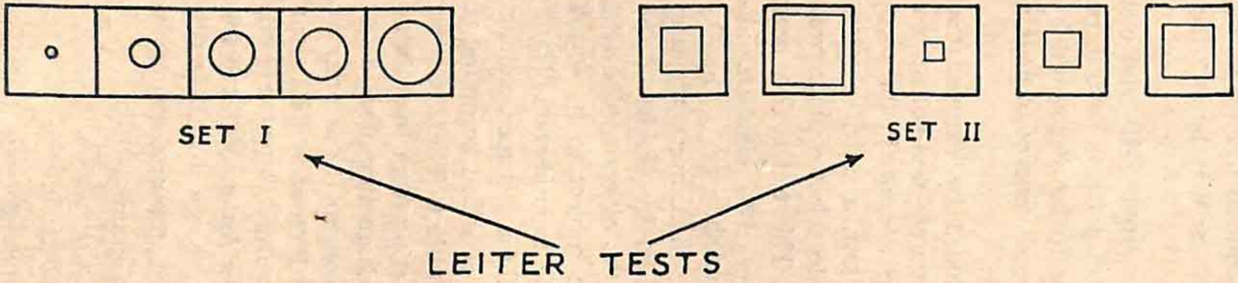


FIG. 16

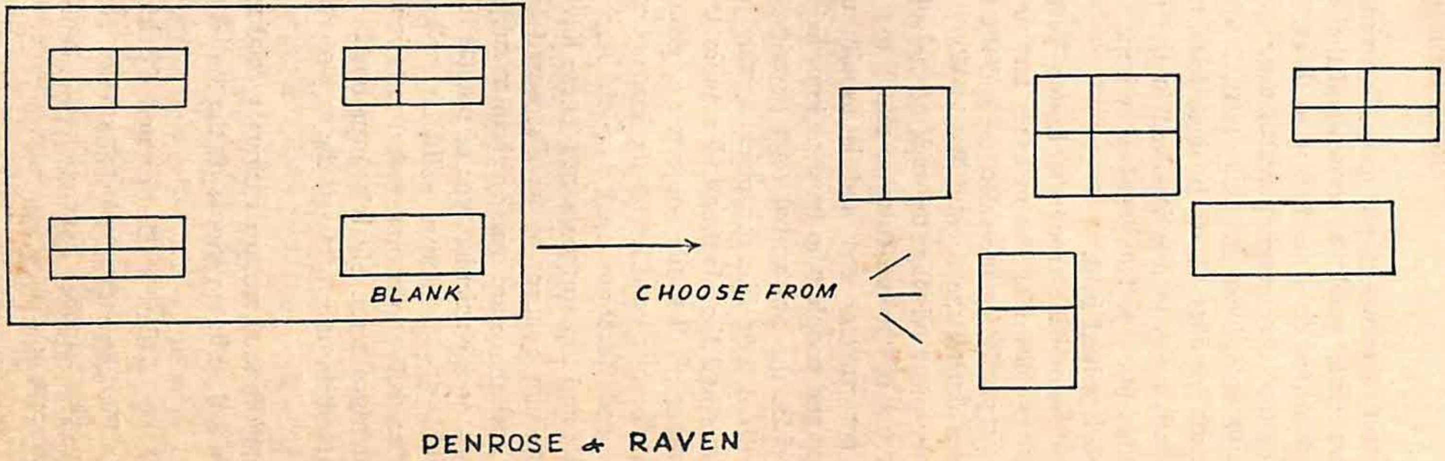


FIG. 17

(d) Cattel tests
(e) Collins and Drever tests

DISTRIBUTION OF INTELLIGENCE

The population of any community would contain individuals of all levels of intelligence starting from the idiots to the very brilliant. If the IQs are polotted against frequency (the number of people falling into each IQ level) the resulting curve would be bell-shaped, the crest of the curve indicating that the greatest number of people in any community would have average IQs (between 98 and 105). One tapering end of the curve would show the number of feeble-minded people and the other end would show the number of geniuses.

People falling under particular ranges of IQs are classified under specific categories.

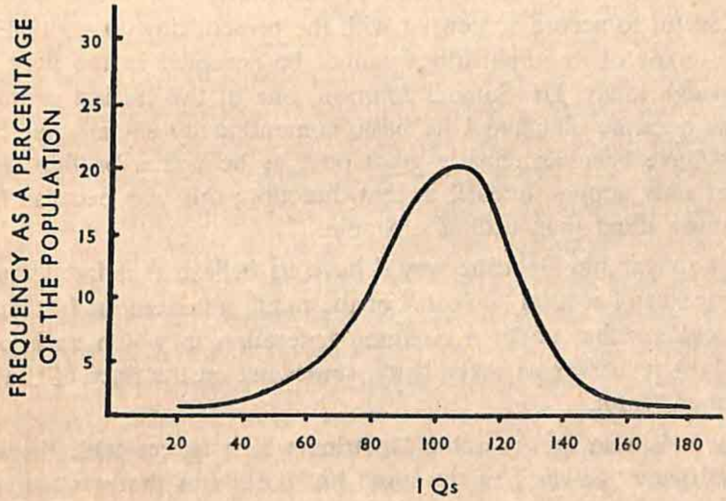


FIG. 18

Cattell's Classification	*IQ*	*Frequency Percentage*
Genius	170 and over	0.2
Very brilliant	160 to 170	0.3
Brilliant	150 – 160	0.6
Very superior	140 – 150	1.4

Superior	130 – 140	3.5
Very bright	120 – 130	9.0
Bright	110 – 120	15.0
Average (Sup.)	100 – 110	20.0
Average (Inf.)	90 – 100	20.0
Dull	80 – 90	15.0
Dull (Inf.)	70 – 80	9.0
Borderline		
Mental Defectives	65 – 70	2.2
Feeble-minded	45 – 65	3.1
Imbeciles	25 – 45	0.6
Idiots	25 and below	0.1

THEORIES OF INTELLIGENCE

One of the oldest theories of intelligence is the Monarchic Doctrine which considered intellectual ability as a sort of presiding deity operating and controlling all activities of the individual. While its general form seems to accord somewhat with the present day concept of intelligence, many of its implications cannot be accepted in the light of our knowledge today. Dr. Samuel Johnson, one of the earliest protagonists of this doctrine elucidated its basic contention by saying that Newton would have been an equally great poet as he was a brilliant scientist had he only applied himself in that direction; this was because Newton had more mind than ordinary people.

The Oligarchic Doctrine would have us believe that intellectual ability consists of several "powers" of the mind, autonomous in themselves but held together under a common federation in which each of them somehow preserves its sovereignty, somewhat on the lines of the British Commonwealth.

There is also an Anarchic Doctrine which agrees with the concept of the many "powers" of the mind but postulates that each of these is absolutely independent of the others because there is no integrating mechanism. According to this view, what we call general intelligence is only the average of all these different attributes.

Actually the three views mentioned above cannot be referred to as theories because their formulation is ambiguous as also non-quantitative, and as such can be considered only as analogies to help our thinking. One of the best attempts at presenting an acceptable form of a theory of intelligence in quantitative terms is due to Spearman who also tried to envisage the relationships between various abilities. According to the tetrad equation as it is called,

$$r_{ac} \times r_{bd} - r_{ad} \times r_{bc} = 0$$

where *a, b, c,* and *d,* denote 4 abilities and r_{ac}, r_{bd}, r_{ad} and r_{bc} respectively represent the coefficient of correlation between each pair of abilities. Spearman envisages intelligence as consisting of two aspects, *G*—the general factor which remains quantitatively and qualitatively constant for the same individual irrespective of the task to be performed and *S*—a specific factor varying in the same individual from one ability to another. Factor *G* is envisaged as differing from person to person and can be identified with the quality which is popularly referred to as intelligence. However, Spearman refused to define *G* on the plea that to call it by a specific name would amount to describing one unknown entity by another. This theory is also known as the Two-factor theory of intelligence. Though it held sway for a long time it had many critics who felt that unqualified support to the theory has not been provided by later experimental findings. For instance, Sir Cyril Burt, as a result of his experiments on school children, found evidence not only for specific abilities as Spearman envisaged, but also for group factors each of which incorporated a number of specific abilities. An example of a group factor would be Musical ability which endows the individual with ability to discriminate between good and bad music, to memorize musical scores, to perform on a musical instrument, to sing and so on. Similarly, mathematical ability includes such specific abilities as aptitude for work with numbers, capability to perform calculations and memory for figures—just to quote a few. Verbal ability is yet another group factor. As result of these findings Spearman's Two-factor theory had to be modified to a Three-factor theory. Recently, Valentine (1957) has described another group factor which operates in all spheres of intellectual activity and this is the Reasoning Ability. While there is no doubt that there may exist such an ability it does not seem quite necessary or practicable to consider this as separate from the general factor of intelligence. Behind every task to be performed is the ability to reason and therefore this factor may be considered as an integral part of general intelligence.

The concept of intelligence is still changing. Dr. E. Webb, using university students as his subjects, found evidence for 48 mental qualities as also another general factor which last he described as being independent of *G*. This has been termed *W* or persistence. Dr. Maxwell Garnett another investigator in this field re-analysing Webb's data discovered another general factor *C* which he termed cleverness. It is easy to see how various combinations of these three general factors—*G*, *W* and *C* may produce an inexhaustible variety of human abilities.

HEREDITY AND ENVIRONMENT: THE NATURE OF INTELLIGENCE

The question as to whether intelligence is inherited or acquired (developed) is a long-standing controversy. Arguments have raged for and against the concept that intelligence is determined by heredity and to take sides in this dispute would not be the best way to learn all about intelligence. Systematic experimentation has disclosed several interesting facts. The study, in particular, of identical twins provides a very good method of investigating this problem because such twins are found to have the same heredity. This in turn is because they are formed in the womb by the later division of a single fertilized ovum. Identical twins even when separated early in life and nurtured in quite different environments have been known to resemble each other very much in their abilities; in addition, their habits of life and thought are often found to be identical. Such close similarity may seem fantastic to anyone who has not observed them closely for some time. A typical experiment with them would be that in which one of the twins is reared in the town and given all the opportunities for furtherance of his education as also for enlightenment while the other is allowed to grow up in his native rural surroundings with his own parents who, let us say, have only average intelligence. Such experiments have been performed and subsequent tests of intelligence disclosed a difference of a few points in favour of the town twin. But this difference has not been found to be large enough to warrant the idea that intelligence can be developed as a result of subjection to the influence of a select environment. On the other hand, there is the observed fact that children living in an orphanage or any other such institution, show a surprising degree of similarity in intelligence levels. In this case individuals of widely differing heredity are subjected to the levelling influence of an identical environment, or so it seems. However, the correlation between the intelligence of a child in such a situation and that of his parents has been found to be higher than that among the inmates.

Strong evidence for heredity determining intelligence comes from Galton's study of the family tree of geniuses as also of criminals; he found that genius as well as criminal tendency tended to be transmitted from father to son even in specific directions. Comparing 214 foster children with 105 children still living with their parents Burks found that generally the IQ correlation between child and foster parent was very much lower than that between the child and its own parents. As a result of her findings she estimated that out of all the contributory factors responsible for the growth of intellectual ability only 17 per cent may be said to be due to environment while from 75 to 80 per cent would be due to heredity. Sir Cyril Burt also agrees regarding the subsidiary part played by environmental conditions in determining intelligence but he thinks that only about 50 per cent of the total influence may be due to heredity.

On the other hand, evidence for the definite influence of environment on intelligence comes from several quarters. Otto Klineberg (1935) compared urban and rural Negroes in America and found that the city bred ones scored higher in intelligence; he found the same difference between the city-bred and rural children of Paris, Rome and Berlin. Among the army recruits in the U.S.A. those coming from states having a better educational system showed a higher performance in tests of intelligence. Cattell's tests with the city children of Leicester and the country children of Devon showed about a 7-point superiority of the former. Jones, Conrad and Blanchard performed similar tests and arrived at almost identical results.

The evidence for and against the innate (hereditary) determination of intellectual abilities makes the whole controversy so full of confusion. However, when the nature of these tests of intelligence is very closely examined one cannot but feel serious misgivings as to their validity. Most tests are verbal in character and relate to things that the city child is very familiar with and the rural child is not. Needless to say, the latter would be at a disadvantage not only as regards the substance of such tests but also on account of his limitations of vocabulary. If the rural child is given an opportunity to make good this deficiency, the difference in performance between himself and the city child may become negligible or even non-existent.

There can also be another way out of this quagmire. This would be to accept a theory like Hebb's which formulates two aspects to intelligence, one the innate hereditary element not directly measurable by the tests in vogue at the present time, and another the modifiable aspect which can be moulded as a result of experience. These have been referred to as intelligence *A* and *B* respectively. If as Hebb believes, Intelligence B can be developed by experience this is a strong argument for providing equal opportunities for all children to develop their intellectual capacities to the fullest extent. As various personality factors also come into play in determining the development of an individual, it is clear that even an objectively similar environment need not lead to identical development of intelligence.

OTHER ASPECTS OF INTELLIGENCE

The data from a large number of tests conducted in Western countries on various samples from the population, have failed to disclose any superiority in intelligence so far as the sexes as concerned. But among the male population a greater percentage of the members have very high IQs than in the case of women. This is offset by the presence of a larger number of people of very low intelligence among the men. Freeman, Holzinger and Mitchell (1937) conducted a very important experiment to find out whether there is any definite relationship between family circumstances and intelligence. They found that not only did children from poorer homes show less IQ's than those from richer homes but they also registered smaller gains in IQ consequent on progressive education. Thomson found that this was also related to the size of the family, the larger families tending to produce lower IQ's than the smaller ones. An analogy which would elucidate this relationship would be to think of a standard reservoir of IQ's available to each family; the larger the family the smaller the share of each member and vice versa. But there is the danger that such analogies may sometimes be quite misleading. The real explanation of this phenomenon seems to be this: parents of more than average intelligence show foresight in planning and having small families whereas those of inferior intelligence do not seem to do so. This kind of reasoning would no doubt explain Thomson's findings but these results need not necessarily apply to other countries where such experiments have not been conducted. For instance, in societies in which large families are the vogue and are sanctioned by religious and ethical considerations, the results of intelligence testing may be quite different.

Woodworth and also Vernon claim to have obtained evidence which seem to suggest that intelligence may differ in different races. However, as Arlitt has pointed out, this seeming inferiority may be due not to inherent intellectual variations but to differential opportunities for development available to members of various races. This view seems to be corroborated by many instances of individuals from the so-called backward races who, when given the opportunity to develop their latent capacities, have shown themselves brilliant in the sciences and the humanities. Taking all this into consideration one can only say that so far we have not had sufficient proof to demonstrate any inequalities of intelligence merely due to racial origins.

AGE AND INTELLIGENCE

It would come as a shock to most people when they are told that after the age of 16 or so, a person's intelligence stops growing. A few people may indignantly repudiate this statement adding that they know now much more than what they did at sixteen. They would be perfectly right in so far as the extent of their knowledge is concerned, but intelligence does not necessarily depend on the amount of knowledge a person possesses even though its acquisition is facilitated by intellectual abilities. Intelligence coupled with experience and knowledge becomes a powerful force which also gives the impression of superior intelligence in a person of mature years. Apart from a few exceptional individuals who continue to develop in intelligence after their teens, the majority of adults do not perform better in an intelligence test for that particular IQ range than a boy of sixteen. Although this appears to be a strange provision of nature, it must be realized that a period of growth also represents a time of immaturity. Intellectual development has to be stabilized at some stage or the other so that the individual may begin to mould his capacities to more mellifluous dimensions with the help of experience. Taking all these facts into consideration it should be considered a boon that we attain the limit of our intellectual development at mid-adolescence.

PRODIGIES

Almost everyone has come across or read about people who can perform the most astounding calculations in the twinkling of an eye and retain in memory a variety of facts over a long period of time. There are many theories about such people. When a lightning calculator is asked to introspect during his performance, he usually states that he is unaware of any logical reasoning or conscious juggling with numbers. Suddenly the answer flashes into his consciousness. Whether it is a rapid subconscious activity, unhampered by inhibitions as in the case of conscious operations, or a type of intuition it is hard to say. But one thing seems to be apparent and that is, such people do not necessarily make good mathematicians; nor is their IQ of a high order as a rule. In some cases lightning calculators have been known to have an IQ less than average.

CHAPTER SIX

THINKING

OF ALL types of behaviour evinced by a human being, perhaps thinking is the hardest to define partly because it is not an overt activity although there may be some concomitant observable physical changes. Most efficient thinkers however, keep absolutely still and it is only as a result of their own admission that others become aware that thinking has taken place. Before attempting to define such an abstract phenomenon, it would be better to discuss other aspects of thinking which are known or can be easily inferred as a result of observation.

An organism has to have commerce with the environment and become aware of the interaction between them before it can develop an efficient mechanism to cope with thinking of any kind. The results of external occurrences which leave an enduring effect are usually referred to as memory traces or sometimes as engrams. Thus far it does not seem to present any difficulties, but a consideration of how exactly the memorial traces are formed and what their nature is, becomes a more complicated task. For the sake of convenience, the process by which we become aware of external events with the help of the sense organs is subdivided into sensation and perception. The sense organ which registers the stimulus, transmits only a neural electrical current which in some qualitative way reflects the external event. The effect of an external stimulation on a sense organ is sensation; it has to be interpreted by the brain and a definite meaning given to it which latter operation is perception. Usually these two processes take place so close to each other that awareness is an almost instantaneous process and even a skilled introspectionist would find it hard to separate a pure sensation from the total experience.

There can be various levels of thinking. In the simplest of these known as perceptual thinking, a percept is formed through a sensation, in which case there occurs more or less a faithful reflection of external things. In perceptual thinking a certain amount of discrimination among stimuli takes place. When we consider the nature of our sense organs and the constant barrage of innumerable stimuli impinging on them it would be an intolerable situation if all these led to awareness. From this disordered medley of stimuli the perceptual mechanism carefully selects those sensations which should lead to awareness, all the rest being ignored. This is a fascinating filter arrangement the exact nature of which has still to be discovered.

Imaginative thinking may be considered to be a higher level of thinking because in this operation, thinking does not consist in giving meaning to sensations currently present. The residues of sensations long past, the images as they are called, are arranged in a particular order by the mind. When these images are brought up again we have memory images and imaginative thinking consists in re-arranging these images. Memory images can belong to any sense modality; for instance, we can imagine the smell of a rose and it becomes an image of smell; we can also have the auditory image of a train whistle or the visual image of the smoke rising from the chimney.

One of the earliest systematic studies of imagery undertaken, was by Sir Francis Galton (1880) who sent out a questionnaire to a number of people asking them to form mental pictures of various objects and of their qualities and to try to describe their impressions about them. For instance, he required them to visualize the breakfast table—the steaming pot of tea, the crispness of the bread, the tastes of the butter and the marmalade and so on. When the replies were analyzed and classified many interesting facts came to light. In some people whom Galton termed visiles, visual sensations seemed to predominate; the audiles had clear auditory images. These two classes of people seemed to form the majority and there were also a few individuals who could form outstandingly clear kinaesthetic images. Betts (1909) followed up this study and discovered that as a rule individuals found to be good in one kind of imagery tended to be good in others too. He analyzed the style of authors in an effort to classify them into the various imagery types; if an author used too many expressions to describe the appearance of places he was classified as a visile; if he described sounds to the near exclusion of other images then he would be an audile. For a long time it used to be thought that imagery or the ability to form these memorial images was necessary for outstanding brilliance of achievement in any field. But a survey of the imagery of well-known scientists disclosed that many of them had none at all. The direct implication of this finding is that imagery may not be essential to thought processes and this brings us to the controversy regarding imageless thought. In a nutshell, this dispute revolves round the idea of whether or not thought processes can be carried on without the formation of verbal pictures of objects and events. It was maintained by one school of thought that even in cases where words cannot evoke definite pictures, we do have a picture of the written word. To give an instance; suppose one thinks of a word like 'reticence' what other mental picture can be formed? It is such an abstract quality which would defy attempts at personification. Does one actually have a mental picture of the word as it is written down? And if one can have thoughts without images, how can their existence be proved? These are questions which have to be answered.

Almost everyone is aware that at certain times a diffuse kind of feeling about a meaning can be present in consciousness and that this meaning is not present as words or images. Again when one is trying to recollect a forgotten word, the general meaning of the word is present but not the word itself. T. V. Moore performed some interesting experiments to demonstrate the existence of imageless thoughts by presenting incomplete pictures to subjects and asking them to say what they were. After the subjects had identified the pictures they had to give an introspective account of all their thought processes which intervened between presentation of the picture and its recognition. For instance, when a vague outline was identified as a bird by a subject he usually said that he first knew that the picture was that of a bird and then formulated it as a word. In another experiment performed by Woodworth, subjects were given a problem to work out. After its successful solution they had to give an introspective account of the thought processes which occurred between presentation of the problem and the emergence of the answer. The results of their experiment also made it clear that it is possible to have some thoughts which are not images of anything.

An important offshoot of the imageless thought controversy was a revolutionary theory by J. B. Watson (1914) who believed that thought processes were in no way mysterious. These processes resembled other overt activities and were only implicit speech. Watson believed that even in the most unobservable thinking process, there would be some vocal movements which could easily be detected if there were only suitable instruments available. He proceeded to test his hypothesis by applying cup-like contrivances to the tongue the movements of which were transmitted by a system of levers to a paper recording machine. By this means some movements during thought were recorded but later on better designed and more sensitive devices failed to show evidence for such movements. This failure has led to the belief that the crudity of the original apparatus might have produced strains in the muscles which resulted in initiation of movements. So the theory that thinking is merely subvocal speech cannot be said to have been conclusively proved.

However, there has been definite empirical evidence of the flow of action currents as a result of thought. These currents are electrical discharges produced in the muscles even when the latter show very slight contraction. For example if a subject is asked to think of lifting his right arm an action current immediately flows through the right arm; if he thinks of looking upward, action currents flow in the retina. A thought relating to any particular part of the body initiates an action current in that part. A very interesting discovery by Max (1937) was that in deaf-mutes, thoughts of speech initiated action currents at the tip of their fingers and not on the lips! This is because these people use a finger-code for carrying on a conversation.

In another experiment, Davis (1937, 1938) tapped the action current from the neck and from the arm of a subject and led it to an oscillograph. When a very difficult problem was to be solved, action currents built up rapidly and when the subject was about to solve the problem the current diminished. It was also found that familiarity with a task reduced action currents. Woodworth and Schlosberg think that action currents instead of being an indication of efficient thought processes may really represent difficulties encountered; therefore greater efficiency and facility of thought go with diminished action currents or even with the absence of them.

A prolific amount of experimental evidence seems to support the existence of imageless thought but it is surprising to know that great mathematicians and physicists often think in terms of symbols; this seems to be necessary in order that a clarity of expression may be achieved.

Imaginative thinking may further be sub-divided into different levels. Immediately after the presentation of an object, it is possible to have its image which is the primary memory image, a faithful copy of the original but not so vivid. Many people claim that they have a photographic memory in that the image of any object is as clear as the original itself. From time to time such claims have been investigated but in most cases these could not stand up to stringent experimental tests. For instance, if a letter square is presented for a brief duration to such a photistic visualizer and later he is asked to read the letters diagonally, clockwise and anti-clockwise respectively, he should be able to pick out the letters quite easily from memory if he has a clear picture of the square in his memory. But most people have been unable to do so.

However, Jaensch in his experiments with children and adults found conclusive evidence in support of a phenomenon known as Eidetic Imagery which helps some children to form so vivid a mental picture of an object that they can note with extreme clarity even the minutest detail as if the object were still present before their eyes. These memory images appear almost like hallucinations. However, eidetic imagery has been found to be extremely rare in adults. Blackburn is one example of an adult who has such imagery; he finds it easy to play chess blindfolded against three opponents at the same time and claims that he can clearly remember the position of every piece in every one of the three boards. Probably people who can perform different tasks at the same time also might be having very vivid visual imagery which enables them to leave off one task at a certain stage of completion, perform another, and then resume the original task. Galton has given instances of public speakers who could "see" the contents of their scripts with such clarity that even illegible corrections in the original got them stuck in the middle of a speech.

Reproductive imagination consists mainly of bringing to mind images of past experiences. In this type of imagination there is no rearrangement of the elements but only a sort of re-living of the past in which all the events are preserved in their original context. It is necessary however that a certain restrictive influence be brought to bear on this kind of imagery to prevent haphazard combination of the images as happens in a day dream. But however haphazard seems the connection between images in a brown study, protagonists of Jung's word association tests claim that when one word is given as a response to another that demonstrates a definite association between them.

At the highest level is conceptual thinking which is involved in any kind of worthwhile mental process leading to some constructive results however insignificant these may be. Before proceeding to a full analysis of conceptual thinking and its implications there are two laws of noegenesis formulated by Spearman which attempt to elucidate the principles involved in thinking. The first of these, the principle of eduction of relations states that "the mental presentation of any two or more characters (simple or complex) tends to evoke immediately a knowledge of the relation between them". Thus if two characters blackness and whiteness are brought to mind we become immediately aware of the relation between them, that they are "opposites".

The second law, the principle eduction of correlates states that "the presenting of any character together with any relation tends to evoke immediately a knowing of the correlative character". Taking the same examples as before, if the character "whiteness" and the relation "opposite" are presented together we immediately become aware of the correlate "blackness". In the analogies test used in most intelligence tests, these two principles are widely applied.

CONCEPT FORMATION

One definition of learning is that it is the ability to classify various objects and attributes under definite categories; when this ability has been acquired it means that the organism is able to abstract the common characteristics from a large number of items and to give them a common name. This process is termed concept-formation. C. E. Osgood (1953) expresses the matter cogently when he describes a concept as the "common response made to a class of phenomena the members of which display certain common characteristics". And the ability to form concepts is not the monopoly of human beings. It has been demonstrated at all levels of phylogeny as the experiment described below will show:

Lloyd Morgan once tried a very interesting experiment with young chickens. He observed that chickens usually avoided the black and gold caterpillars known as cinnabar larvae because the taste of these was unpleasant. Choosing a naïve flock of chicks which had had no opportunity of coming across cinnabar larvae, Morgan established a differential feeding habit in them by the following procedure. Two plates of glass containing food which looked the same but tasted differently, were kept in the chicken run. One of these plates had black and orange strips of paper pasted underneath it and on it was kept a mixture of meal and quinine moistened with a little water. The other plate of glass was untreated and on it was placed ordinary meal, only moistened with a little water. After a few trials, the chicks learned to avoid the bitter meal on the black and orange plate and to go to the other.

Later, even plain meal offered on the black and orange plate was avoided by the chicks thus demonstrating the establishment of a strong avoidance habit. Then a mixed bag of caterpillars consisting of the edible kind and the black-gold cinnabar larvae was exposed near the chicks and their feeding behaviour closely watched. The chicks invariably avoided the cinnabar larvae demonstrating the fact that they had learned to associate orange and black bands with non-edible substances. This is a typical example of concept formation.

Ascending the phylogenetic scale rather rapidly, one finds that human children make very fascinating subjects for such experiments. The main work in this field was done by J. Piaget in the Jean Jacques Rousseau Institute. He observed first of all that very young children are very ego-centric, confusing external happenings with their own imaginings. They consider themselves as being the centre of the Cosmos, and at the same time their thought processes are largely intuitive in that their minds jump straight from premises to conclusions without any attempt at causal explanations. Piaget referred to this kind of intuitive operation of the mind as *syncretism*. Parallel with this growth of syncretism, as a child grows older its concept of the obligation also undergoes a progressive evolution which is clearly demonstrated in the play-behaviour. Piaget found that the very young child had no rules for play. Everyone played as he liked and left off when he chose. Slightly older children, however, became more and more rule-conscious till finally came the stage at which rules of the game became all important and inflexible. When the child grows still older, the concept of social behaviour undergoes another modification. As the intellectually alert pre-adolescent realizes that rules are kept only to ensure uniformity, that they could be revoked by common consent and that a system of carefully graded handicaps could be instituted to mete out fairness to children who, for some reason, are not able to perform as well as the others.

Hull (1920) began a systematic study of concept formation by carrying out a number of experiments. In one of these, he prepared 12 packs of cards, each pack containing the same number of cards and each card being inscribed with a complex Chinese character. A part of each Chinese character referred to as a concept was given a nonsense name like "OO" "LI", "YER" and so on. Though the Chinese characters in each pack were quite different, each set contained common radicals which were part of the whole configuration. In the actual procedure, the experimenter took a pack and exposed each card for a brief interval pronouncing the name of the concept. The subject had to repeat the concept after the experimenter. Then the next pack of cards was dealt with in the same way but the subject had to try to anticipate the concept. If he failed the experimenter prompted him. Though the subjects were not told in advance to look for common elements, Hull found that concept formation did take place in these circumstances in the same way as happens in discrimination learning. This experiment is rather important because it made use of absolutely unfamiliar material and demonstrated that the abstraction of common elements as also the giving of names to them are the common operations in concept formation.

Smoke (1932) believed that even when identical elements are absent or at least not evident, concepts may be formed if different objects evoke common perceptual relations. For example, a ball, a penny, and the sun seem not to have many common features except for the fact that they all possess the common perceptual relation of "roundness". Although Smoke used geometrical figures differing widely in their shapes, the subjects in his experiments were able to group them under a few categories.

Some other experimenters believed that a common mediating process is the most important condition for concept formation while common elements and common perceptual relations only serve to facilitate the process. Reed (1946), in an attempt to demonstrate this principle, prepared several cards on each of which four words were written; one word out of these four was the key word but the subject was unaware of this. The experimenter merely showed each card with the four words on it to the subject and pronounced a nonsense syllable (e.g. DAX) which was the name of the concept. Then the other cards were dealt with in the same way and the task of the subject was to discover what the concept stood for, without getting any help from the experimenter. There were a number of other concepts like ZIG, BEP and so on, and these also had to be discovered in the same way.

Example: The following three cards contained the concept DAX.

1. Answer, Highest, Aeroplane, *Red*.
2. Anywhere, *Green*, Aloud, Butter.
3. Board, breast, *Blue*, Bulb.

In these three sets of words the names red, blue and green evoke the common mediating process, namely "colour". The subject has to link the concept of colour with the nonsense syllable DAX; when he learns this, then the concept would have been established.

Heidbreder (1949) made use of a sorting task. She made a pack of 144 cards on each of which was a different drawing; however, all the drawings represented only 9 different concepts. So there were 16 different cards to represent each concept. The subject was merely told to sort out these picture cards into 9 piles according to any classification he chose to make. Among the concepts were three kinds of things, 3 types of nonsense forms and 3 number groups. Heidbreder found that the subjects were most successful in classifying the thing figures and least successful with number groups. She concluded that concrete objects are the most familiar to the subjects in every day life and therefore these are the easiest to be identified under specific concepts. In terms of the difficulty involved in concept formation, nonsense figures can be considered to be the most difficult because they are the farthest removed from things in real life. Most subjects failed in the number groups because they were concerned with looking for a thing concept and did not realize that it was the number concept which was required.

THE EFFECT OF BRAIN LESIONS ON CONCEPT FORMATION

Gelb, Goldstein and Scheerer conducted experiments on soldiers suffering from traumatic lesions of the brain especially in the frontal lobes, as a result of which two levels of conceptual thinking became apparent —the abstract and the concrete. While most normal intelligent people use concepts at an abstract level, people with certain types of brain injury are unable to do so. For instance, if such a subject were asked to show how to drink out of a glass, he would be unable to demonstrate if the glass happens to be empty. If he is asked to bring a comb to the experimenter, he would be unable to do so without first running it through his hair.

Several tests have been devised to demonstrate the abstracting ability of a subject. In one such test, subjects are given a box of coloured yarn to sort into specific categories. In the object-sorting test devised by Goldstein, Gelb, Weigal and Scheerer (1941) a number of objects such as a spoon, knife, hammer, chocolate, cigar, candle and so on are spread out in front of the subject who has to sort them into categories under three different experimental conditions, (a) according to a classification chosen by the subject himself, (b) by grouping all articles which seem to belong together, and (c) by classifying them according to a way chosen by the experimenter.

Hanfmann and Kasannin (1937) have devised a test using a large number of wooden blocks of various sizes, colours, shapes and top surface areas. Each block has a nonsense name like LAG, BIK and MUR written on the underside. To start with the subject is told that there are four different types of blocks and that his task is to separate the blocks into these "four" categories without looking at the writing beneath each block. After the sorting is complete the experimenter would turn over the blocks to disclose the writing and the subject has to re-allocate them in their correct positions. The correct classification would have to disregard both shape and colour, taking into account only the size and the top surface area. Thus all blocks which are large and tall belong to the LAGs, the large, flat ones are BIKs, the small, tall ones are MURs, and the small flat ones the CEVs. This test shows the difference between the performances of ordinary people and those suffering from mental illnesses. Whereas the former try out many verbally mediated hypotheses and combine two concepts together, the latter are able to respond only to one characteristic at a time. Sometimes schizophrenics bring all kinds of extraneous factors to bear on these classifications. For instance, Cameron (1936, 1939) narrates how one such subject refused to place yellow blocks with the white ones because there were no Chinese people working at the hospital.

It is clear from all this that brain lesions or organic defects of parts of it may seriously affect conceptualizing ability. For instance, damage to the frontal lobes removes the inhibitory reactions so necessary for the prevention of indiscriminate response to each and every stimulus in the environment. When distraction occurs due to the loss of these regions of the brain responsible for enforcing this inhibitory influence, a high level of thinking becomes impossible.

CHAPTER SEVEN

Emotions

IN psychological parlance, various emotions like joy anger surprise and fear are sometimes described as feeling-tones which implies further that when these emotions are being experienced, the mind instead of being in its quiescent state is being excited in some way.

Some psychologists hold that all emotions are similar in their feeling tone as well as quality; the perceived differences are only due to the various situations with which they are associated. An example of this would be the emotions of fear and anger both of which may engender the same physiological and mental states although they are said to be quite distinct. It should also be realized that an emotion has duration in time and may trigger off a series of behaviour sequences culminating in a worth-while end as perceived by the behaving organism. In this respect we can do no better than to refer to the eminent authority on instincts, McDougall, who postulated that each instinct has an emotion attached to it and that the behaviour sequence stemming from an instinct is largely directed by the emotional core inherent in it. This point of view, however, has not gone unchallenged. Drever and Rivers for instance are of the opinion that although an emotion may be latent in an instinctive performance, it does not manifest itself unless the particular behaviour is thwarted in some way. According to these authors, then and only then does the emotion take over. In support of their contention they point out that escape from danger is very often unaccompanied by feelings of fear whereas the moment a person in danger imagines or actually sees all his ways of escape blocked, then a wave of fear sweeps over him. But it is clear that Rivers and Drever on the one hand and McDougall on the other do not substantially differ in principle; the difference in their respective points of view arises mainly in relation to the degree of manifestation of the emotion. Summing up the general principles involved in the behaviour of organisms, it seems safe to assume that for behaviour to take place there must be an appreciation of the end in view, (however dim the goal might be) and also a feeling of worthwhileness which last may be identified with a degree of emotion. Finally, it seems as if emotion and behaviour are inextricably bound to each other.

THE ACTIVATION THEORY

This theory due to Lindsley (1951) is the result of a great deal of experimental study coupled with observation. All living creatures throughout their life are activated, the degree of such activation depending on the behaviour taking place at a particular time. A soundly sleeping man is at the least level of activation while at the other extreme a man indulging in restless behaviour may be said to be intensely activated. Zero activation would be impossible for any living organism because that would signify death. Physiologically interpreted, activation is only energy-mobilization the degree of activation depending on the amount of energy available at a given moment. The activation theory postulates that the hypothalamus, energized by impulses, discharges into the cerebral cortex. The introduction of the electro-encephalograph (E.E.G.) helps us to follow the activation levels; in sound sleep or in a quiescent state the rhythm shown by the EEG is a pattern of uniform waves the crests and troughs of which do not show sudden changes. This is known as the Alpha Rhythm. When a subject wakes up the increased activation level is also indicated by the change in the EEG pattern.

The term activation, if defined as the rate of energy-mobilization, has the same meaning as emotion because the latter also mobilizes one's energy and prepares for action. Though in all types of behaviour a certain amount of emotion may be present, directive action may be possible only when there is an optimal level of activation. A lower level than this would not spark off the reaction because of the low grade of worthwhileness feeling: on the other hand though a very high level of activation represents a high level of energy mobilization, it permits of only a blind, impulsive action devoid of the finer directive influences. Thus the term "blind with rage" literally expresses a condition of overstimulation of the emotions leading to non-directional behaviour.

THE JAMES-LANGE THEORY

The American philosopher William James and a Swedish physiologist named Lange independently arrived at similar results at about the same time and their combined findings have been incorporated into a theory known as the James-Lange theory of emotions. According to this, emotions are nothing more than our awareness of the changes that take place in the viscera. This seems at first sight contrary to the commonsense view which holds that a situation produces the emotional effects first and as a result of this physiological change or suitable behaviour takes place. For instance, when one perceives a danger, a sudden feeling of fear occurs which impels one to flee, the emotive element thus occurring between the situational sequence and the behaviour sequence.

But the James-Lange theory reverses the order; one sees the danger, flees and feels afraid, the emotive element appearing last as a concomitant to behaviour. This theory implies that there are intrinsic patterns of behaviour inherent in a situation itself so that when the situation arises the behaviour is triggered off. The emotion suffers a time-lag as it were and is brought into the picture only after the behaviour has started to function. It seems rather hard to substantiate the James-Lange theory. One of the few pieces of evidence in support of it comes from the fact that it is possible to induce artificially certain emotional states by the administration of appropriate drugs into the blood-stream. For instance it is now known that under conditions of intense fear or anger, the adrenal glands secrete large quantities of adrenalin which has the effects of mobilising energy for combat or flight and of increasing the coagulating property of blood so that a person if wounded, will not bleed to death. A direct test of which follows which, whether the emotion follows the physiological changes or vice versa can thus be performed by injecting a sufficient quantity of adrenalin into the blood stream and by carefully observing whether this causes emotions of fear and anger. This type of experiment has been tried; some subjects reported genuine feelings of fear; some others reported a peculiar sort of feeling as if they were wanting to feel afraid but at the same time knew that there was no cause to do so. This latter type of evidence is a revealing fact because it shows that although the administration of adrenalin leads to the production of an emotion it does not produce a specific effect. The conclusion seems to be that though emotions may sometimes be said to follow physiological changes, these visceral changes have to be interpreted by the subject in the light of the situation existing at the moment.

Evidence against acceptance of this theory has been forthcoming from the results of experiments conducted by Sherrington. He used a spinal dog (a dog with the spinal cord severed at the lower cervical region) in these experiments and found that when a person whom the dog liked approached it, all signs of recognition and joy were registered; when another whom it disliked came near it showed all the signs of fear and rage. In this experiment no information of viceral changes could have reached the brain but still the emotions were in evidence.

TRI-DIMENSIONAL ANALYSIS

Though the task of classifying feeling-tones is none too easy on account of the innumerable combinations possible, Wundt thought that a system of three dimensions of feeling would be a satisfactory one and would incorporate the basic feeling tones. The three dimensions are: (1) pleasant-unpleasant (2) excited-quiet and (3) tense-relaxed. Titchner, another well-known experimenter during the early days of psychology, recognized only the pleasant-unpleasant dimension as basic in so far as feelings are concerned and considered all the others as only sensations.

THE PHYSIOLOGICAL BASIS OF EMOTIONS

It is now known that the autonomic nervous system is the mechanism involved in the production of emotions. It has two divisions, the sympathetic and the parasympahetic which have opposite effects on the various systems in the body. For instance, when someone is experiencing great fear, it is the sympathetic system which causes the minute blood vessels of the skin to contract making the face appear pale. At the same time the supra-renal glands, situated above the kidneys secrete adrenalin into the blood-stream. Adrenalin places the whole system in a footing of war, causing the liver to release more energy in the form of glycogen and increasing the coagulatory power of the blood to prevent undue bleeding in case of wounds. The sympathetic system also inhibits all anabolic processes like digestive activity and stimulates heart as well as lung action. The parasympathetic system is more concerned with conservation and up-building; it stimulates gastro-intestinal digestive activity and the storing of sugar in the liver. Its action is also evident in the contraction of the pupils when exposed to intense light and in the spasm of the bronchioli in expelling irritating substances.

The exact part of the brain which initiates emotion has been one of the problems intriguing scientists for a long time. Cannon (1920) thought that the optic thalami of the middle brain were responsible for initiating emotions. Using cats as subjects he severed the connections between the brain stem and the cortex at progressively higher levels. When he removed the upper brain leaving the optic thalami intact, exaggerated rage reactions were obtained. Similar observations on human beings with head injuries corroborated Cannon's findings. This exaggerated emotive aspect was at first thought to be due to the removal of the inhibitory influence contributed by the upper brain. Subsequently, Bard found that the severance of the upper brain caused irritation of the severed ends and it was this which resulted in the production of heightened emotional states. As a result of this discovery the hypothalamus came to be thought of as the centre for initiating the rage reactions but even this view is no longer tenable because of the discovery that even the hypothalamus acts only as a relay station for impulses initiated elsewhere. Moreover, the picture of the upper brain as merely an inhibitory centre is not held to be valid any longer because it has been found to have an excitatory function also. It is now thought that fear reactions are mainly initiated by the frontal lobe of the brain and hence pre-frontal leucotomy is performed on people suffering from pathological anxiety states. But there is one great drawback in lobectomy in that the operation removes also most of the inhibitions, with consequent loss in the sense of responsibility.

EXPRESSION OF EMOTIONS

Emotion need not always be a response to the situation in which one finds oneself, but it may also be elicited by sympathetic induction on perceiving the distress of another person. In crowds and congregations of people, the sympathetic emotion travels at a fast rate till the whole group is seized with an overwhelming unanimity of emotion. Animals are sometimes capable of sympathetic emotion. Köhler describes how chimpanzees on seeing the distress of one of their number in an adjacent cage, would embrace the distressed one through the bars of the cage.

There is another type of altruistic emotion which seems to be the monopoly of human beings and which is called forth when perceiving the impending danger to a companion who himself is unaware of it. Various experiments (described elsewhere in this book) have demonstrated that animals do not experience this type of emotion and are influenced only when they see as well as hear a companion in distress.

As regards expression of emotions, modern society tends to disapprove of any overt manifestation of one's internal emotive states. An individual is expected to show a placid front even when he may have reason to feel worried. But man has not so far conquered himself so as not to betray the least sign of emotion; at least the majority of people have not succeeded in doing so. There always occur sundry twitchings of muscles and there may also be other signs which always give away the game. The careful observer will always be able to detect these insignificant overt signs of an emotional state. However, it needs to be emphasized that the damming up of these emotions may lead to stresses and strains, sometimes even resulting in neuroses.

TEMPERAMENT AND TYPOLOGY

Temperament has been defined as the total pattern of a man's emotional reactions. To give an analogy, in the study of geography we say that the climate of a country is distinctive to itself and provides the specificity which enables us to differentiate it from other countries. As climate is to a country, temperament is to man. It places him in a particular category so that under given environmental conditions, if may be fairly easy to predict the general direction his reactions will take.

Attempts to classify men and women into types have been made from the earliest times. The Hindu sages of old divided people into definite classes depending on the degree of animal propensities present in their make-up. Hippocrates as also Galen spoke of four different types of people, the sanguine, the phlegmatic, the choleric and the melancholic. The sanguine type is distingiushed by an excess of blood and is characterized by rather superficial emotional reactions. The phlegmatic person shows an even temperament at all times though he may be slow to think and react. The excess of bile one possesses was supposed to make for nervousness, overactivity and irritability—the marks of the choleric individual. Finally, the melancholic individual was supposed to derive his pessimism and depression from an excess of black bile. This division has endured down the ages and, with very slight modifications relating mainly to the alleged physiological causes for these differences, is still accepted as a valid system.

The ability for "eidetic imagery" was made use of for effecting a dichotomous classification by E. R. Jaensch who found that there were great individual differences present in persons in respect of this specific trait. It may be recalled that Eidetic Imagery is the ability of some people to have an extraordinarily vivid visual memory image of an object. Most very young children and a few adults can form mental images with such clarity that they can even "project" the image on a plain grey surface and "read off" very minute details. Jaensch distinguished two types of people: (1) the T-type whose facial expression and character formation resembled those found in the disease called Tetany and (2) the B-type which had facial expressions similar to those found in Basedow's disease.

Another two-fold classification is due to the celebrated philosopher William James who categorised people into two types, the tough-minded and the tender-minded. One cannot have many objections to such a reasonable dichotomy but the classification cannot possibly accommodate all the different degrees of tough and tender-mindedness respectively that one finds among people.

Kretschmer's three-fold classification stems from the concept that there may be a definite relationship between physical characteristics and personality traits. His athletic type is characterized by muscular development and large bones; the asthenic type is lean and flat-chested and has narrow shoulders. Both these physical types have been found to predominate among people suffering from schizophrenia, a mental disorder which used to be known as dementia praecox. Therefore both the athletic and asthenic types come under the personality type—the schizothyme.

The third member of this classification—the Pyknic physical type distinguished by obesity, medium stature, soft face, rounded shoulders and a thick neck is commonly found among mental patients suffering from manic-depressive insanity otherwise known as cyclophrenia. Hence the personality dimension corresponding to the pyknic bodily type is referred to as the cyclothymic. However, Kretschmer's typology suffers from two main defects; firstly it was arrived at mainly as a result of the study of mental patients and may, therefore, lack universal application; secondly extensive clinical and other experimental investigations have failed to substantiate in full the validity of the relationship between personality traits and the physical characteristics delineated by Kretschmer.

Another classification which closely follows that of Kretschmer is due to Sheldon who suggested that particular personality traits are related to the degree of development of specific regions of the body. Thus the endomorphic type of physique is characterized by general rotundity and softness with a prominent development of the visceral part of the body. A person who belonged to this physical type would be fond of ease, luxury and comfort, at the same time being extremely gregarious. This type is also referred to as viscerotonic to emphasize the particular part of the body which is prominently developed.

The somatotonic type is distinguished by restlessness, excessive activity, tremendous drive, aggressiveness and some degree of impulsiveness. The physical characteristics of this type will consist in the predominance of muscle, bone and connective tissue and is referred to as mesomorphic.

The cerebrotonic, as the name implies, is the type whose mental life is exceedingly complex. Personality problems tend to predominate and there may be a tendency for introversion with characteristic withdrawal reactions as also love of solitude. Such individuals are lean and lanky having predisposition to suffer from functional ailments like allergies. The physical type showing these personality traits, is known as ectomorphic. The correlation between physical and personality characteristics in Sheldon's classification is high enough to warrant its acceptance as a working hypothesis.

Another way of classifying people would be to divide them in respect of their interests; Spranger's typology is based on six attitudes, theoretical, economic, aesthetic, social, political and religious respectively. An individual who manifests a predominant inclination towards one of these attitudes would be thought of as belonging to that class.

S. Rosenzweig based his classification on studies of mental patients whose reactions to frustrating situations take one of two forms. The exteropunitive person always lays the blame for any personal failures on things or persons outside of himself and therefore very rarely indulges in self-analysis. The interopunitive person, on the other hand, places all the blame for defeat squarely on himself and generally feels a certain amount of inadequacy in dealing with the problems of life. Such a person is seldom at peace with himself. Rosenzweig thought that a normal, well-balanced person is one who possesses a moderate amount of both characteristics and who is able to discriminate between the failures due to one's own limitations and those due to external circumstances beyond one's immediate control. Such an attitude would be mature and has been termed impunitive.

Finally there is the celebrated introvert-extrovert classification due to Jung. An introvert is a highly introspective person who indulges in a great deal of self-examination; his level of aspiration tends to be set too high for easy achievement. His normal withdrawal tendencies are accentuated with every frustrating situation; a person with such personality traits is liable to suffer from feelings of inferiority. It is this which makes him shun the society of other people and also what creates an active dislike of parties or gatherings at which a great deal of social intercourse is naturally necessary. The persistent feelings of actual or imagined inferiority often spurs him on to great efforts in the fields of science and education. Some of the greatest and very brilliant men have been included in this category.

Compared with the introvert, the extrovert leads a down-to-earth existence. Disliking any attempts at self-examination, an extrovert rarely has feelings of inadequacy; he delights in gatherings of all kinds and is conventional to a marked degree. The extrovert loves the limelight and is very often quite materialistic.

The pure types in the extrovert-introvert dimension are not usually met with except in mental institutions. The majority of people are neither pure extroverts nor pure introverts but a blend of the characteristics of both. An individual in whom the introversion-extroversion characteristics are evenly balanced is known as the ambivert. Thus the introvert-extrovert dimension can be considered as a continuum along which can be located any person's position, his rating depending on the predominance of traits which belong to either of these dimensions. Jung further subdivided his types into thinking, feeling, sensation and intuition types.

The following chart will show at a glance the different types of classification which have been considered in this chapter.

1. *Galen and Hippocrates*
   - Sanguine
   - Phlegmatic
   - Choleric
   - Melancholic
2. *William James*
   - Tender-minded
   - Tough-minded
3. *Jung*

Introvert Extrovert Ambivert	Thinking Feeling Sensation Intuition

4. *S. Rosenzweig*
   - Interopunitive
   - Exteropunitive
   - Impunitive

5. *Kretschmer*

Physical Types	*Corresponding Personality types*
Athletic Asthenic	Schizothymes
Pyknic	Cyclothymes

6. *Sheldon*

Physical *Personality*

Endomorphic — Viscerotonic
Mesomorphic — Somatotonic
Ectomorphic — Cerebrotonic

7. *Jaensch*

T-type
B-type } Eidetic Imagery

8. *Spranger*
- Theoretical
- Economic
- Aesthetic
- Social
- Political
- Religious

CHAPTER EIGHT

Conflict, Frustration and Stress

For reasons which seem quite obvious, experimental induction of conflict states have usually been tried out in the field of animal psychology and the results have later been worked into general principles applicable also to human behaviour. Nevertheless, it is neither prudent nor quite scientific to relate the experiences of animals so far apart in the phylogenetic scale as the rat and man, without proper qualifications or further experimentation.

Pavlov, the Russian physiologist whose work on conditioned reflexes has been described elsewhere in this book, was one of the first to produce experimental induction of conflict states in dogs by the application of stress till the animals broke down and behaved in an abnormal way. In one such experiment he first established a conditioned salivary reflex to shock. The shock was progressively increased during the course of a number of trials till the dog finally broke down; it whined and whimpered, bit the harness and generally showed all the symptoms of acute anxiety. After a series of studies using the same experimental procedure, Pavlov discovered that the pattern of breakdown differed according to whether the animals belonged to the "overactive" or the "inert" type; the former type showed violently agitated behaviour whereas the latter just went to sleep in the harness. In another experiment dogs were trained to salivate when a circle was presented but not to do so when an ellipse was shown. The discrimination was then made more and more difficult by making the ellipse nearly resemble a circle. At this stage discrimination broke down completely; the animals showed agitated behaviour and restlessness, and it became very difficult to make them relearn the original discriminatory behaviour. Pavlov termed this aberrant behaviour an "experimental neurosis".

From all his experimental data, Pavlov concluded that there was a clear case for classifying the experimental animals into four types depending on their reactions to stress situations. These types correspond very closely to the classical typology used in the case of human beings.

Classical types	*Pavlov's types*
Choleric	Strong, excitatory
Sanguine	Lively
Phlegmatic	Calm, imperturbable
Melancholic	Weak, inhibitory.

It was also noticed that the violence of behavioural disturbances consequent on equivalent stress situations declined in the order set out above, maximal reactions being obtained in the case of the strong, excitatory type, and the least violent—a state of fear paralysis—being obtained with weak inhibitory types. The calm, imperturbable type showed great tolerance to strain and held out for longer periods before neurosis set in. But whatever be the type of subject used, a sufficient intensity and duration of noxious stimulus or conflict situation ultimately brought about a breakdown. Pavlov interpreted these results as a demonstration of trans-marginal stimulation (stimulus effect exceeding the tolerance limit) engendering a protective inhibition which, in turn, prevented further stimulation. To hasten the onset of transmarginal stimulation, the most obvious method would be to increase the intensity of the noxious stimulus—shock, noise and so on. The same effect can also be achieved by lengthening the delay period between presentation of the conditioned stimulus and the appearance of reinforcement, such a condition in anthropomorphic terms amounting to an increment of suspense with consequent accentuation of anxiety. An anomalous and ambiguous situation in which signals are rapidly varied between positive and negative cue-values can rapidly build up a conflict syndrome in which the animal loses its orientation. Finally physical insults to the organism like castration or deliberate induction of fever or causation of intestinal disorders can create an ideal condition for breakdown to occur.

Pavlov distinguished three steps in the building up of experimental neurosis. In the first, known as the *equivalent phase,* all stimuli irrespective of their relevance to the experimental situation, elicit the maximum intensity of response. Next comes the *paradoxical phase* in which intense stimuli elicit zero response while weak stimuli bring about intense responses. Here the operation of the transmarginal stimulation is apparent. In the third stage known as the *ultra-paradoxical phase* the stimulus-response relationship shows a total inversion, one set of stimuli evoking responses belonging to antagonistic stimuli. Pavlov noticed also that after experimental induction of neuroses the animals involved in the situation took a disproportionately long time to relearn or in some cases even lost their ability to do so. Liddell (1934) noticed a similar phenomenon in his experiments with sheep in which the conditioned stimulus was the ticking of a metronome and the unconditioned stimulus an unavoidable electric shock to its foreleg. The sheep was strapped to a harness on a table and an electrode was attached to one of its forelegs. Though the animal quickly learned to flex its leg when the metronome was sounded it had no way of avoiding the shock. Under these conditions the sheep evinced every indication of acute anxiety and agitation, continuing to behave in an abnormal fashion even when it was liberated from the experimental situation. Relearning became an impossibility with some animal subjects.

In another experiment Maier (1949) trained rats to jump to certain patterns on the Lashley jumping stand and also established a position habit, to jump either to the right or to the left door in the stand. By alternating the pattern cue and that of position in a random fashion, a conflict situation was built up. The rats either suffered violent convulsions as in epilepsy or developed a tedious stereotypy in which they jumped either to the same side always or to the same pattern irrespective of whether it appeared on the right or left.

Masserman (1943) demonstrated the ultra-paradoxical phase of experimental neurosis in cats initially trained to prise open a box with their noses and to eat the food found inside. In the experimental sessions, at the moment of opening of the lid, a puff of air was directed on the eyes of the subjects. Now cats dislike a puff of air on their cornea; and after a series of trials like this they developed an acute form of behaviour aberration which took the form of extreme stereotypy of behaviour and abnormal reactions to known stimuli. When mice were released very close to them, they made no attempt at capture. Instead of eating the specially tasty food inside the box, the cats laid their heads on the food, sometimes showing regression by mewing like tiny kittens.

Barker, Dembo and Lewin demonstrated that when children were frustrated they showed the same pattern of regressive behaviour as animal subjects. Their procedure was to collect a group of children and settle them with conventional old-fashioned toys. After a while, the children devised various improvisations and made believe they were adults; some of them used the rattle as a telephone carrying on a lively conversation with an imaginary friend. When the play behaviour became entrancing, a grille in one part of the room was raised to disclose very attractive mechanical toys. With a wild whoop of joy, the children discarded the old toys and appropriated the new ones. When they were thus playing happily the new toys were taken away into the farthest corner of the room and a transparent partition lowered into place so that the children could just see the attractive toys but not get at them. On returning to their old toys, it was observed that their erstwhile intelligent make-believe disappeared. Thereafter, the play behaviour consisted mostly of random banging of the toys on the floor.

Miller and Dollard have formulated the hypothesis that frustration usually leads to aggression and that while aggression is manifest, the cause would be found to be frustration. In one of the experiments designed to demonstrate the truth of this formulation, Sears, Hovland and Miller subjected six young men to a 24-hour period of deprivation of food and sleep. No amenities for recreation or diversion were provided. As time wore on, all the subjects began to show aggressive behaviour in the form of verbal abuse but since they were all young men well spoken of, they did not evince overt physical aggression. A later phase of this experiment showed that the subjects had become abnormally sulky and taciturn. One of them drew the most gruesome pictures of mutilated human bodies and when asked to say what these figures represented he replied "psychologists"!

A child of six was the subject of another experiment by Krasnogorski who conditioned him to make motor responses to a metronome beating at 144 times a minute. When the conditioning was strongly established the child was required to discriminate between frequencies of 144 and 120. This discrimination was rather disquieting and he became moody and silent and mounted the apparatus with unwillingness. When however the discrimination was pushed to finer limits, between 144 and 132 beats per minute, the child became rude, fought the experimenter, became disobedient and finally dropped off to sleep! The sleep condition probably represents a case of protective inhibition which would have prevented further stimulation.

The experiments described above demonstrate the experimental induction of conflict situations. The nature and results of conflict can easily be observed in the day-to-day life of most people. When there are two opposing tendencies fighting for supremacy neither gaining ascendancy, then we have a clear conflict situation in which vacillation seems to be the villain of the piece. Most average individuals when confronted with such a situation, throw in their lot with one cause rather than suffer the protracted suspense of vacillation. That is why we find people regimenting themselves with causes which the majority of people advocate. By following this sort of behaviour they avoid the uncertainty of indecision and at the same time eliminate the effort of making a decision for themselves. Probably if such people reflect longer on the merits of the matter involved they might have arrived at an entirely different decision. Resistance to change does not mean necessarily a desire for stereotypy but may imply on the other hand an unwillingness to remain in a state of suspense. When a political or religious or social ideology needs to be changed, unless the person concerned makes a quick decision one way or the other, he may unwittingly cause conflict within himself. It is like a plunge into cold water; the more one hesitates the more difficult the initiative becomes.

Before embarking on a discussion of the different types of conflict situations it is necessary to distinguish between two different characteristics of goal objects. Some goals appear desirable and evoke a tendency in a subject to attain it; this leads to approach behaviour. The tendency to get away from unpleasant situations (goals) leads to avoidance behaviour. The two types of goal objects differ in another important aspect also. Desirable goals seem so because their attainment reduces some physiological drive state in the subject (as in hunger, thirst and so on) or usually satisfies a psychological need (attainment of an ambition, need to be appreciated, etc.,); therefore the impelling force for approach behaviour is within the organism itself. Undesirable goals, like noxious stimuli, for instance, elicit avoidance behaviour due to the characteristics inherent in them and not in the organism. These qualities of desirable and undesirable goals have a very important effect on approach and avoidance behaviour respectively. In general the more distant the goal the weaker the tendency for approach or avoidance. But since the organism has within itself the drive state which impels it to approach behaviour, it may be expected that attractive goals still exercise their fascination even at a great distance (physical and psychological distance are both implied here). On the other hand, unpleasant goals may fail to influence an organism when the latter is out of the situation. In psychological terminology therefore, we say that the avoidance gradient is steeper than the approach gradient. These differences in gradient have been experimentally verified by N. E. Miller who allowed rats in a suitable experimental situation to run towards a pleasant stimulus or away from a noxious one and measured their speeds of running. He found, in general, that the closer the stimuli the faster the approach or avoidance. By putting the rats in a harness which was attached to a spring balance, Miller was able to measure the pull they exerted to go near or to get away from the stimulus. The graph shown below clearly indicates the difference between the two gradients.

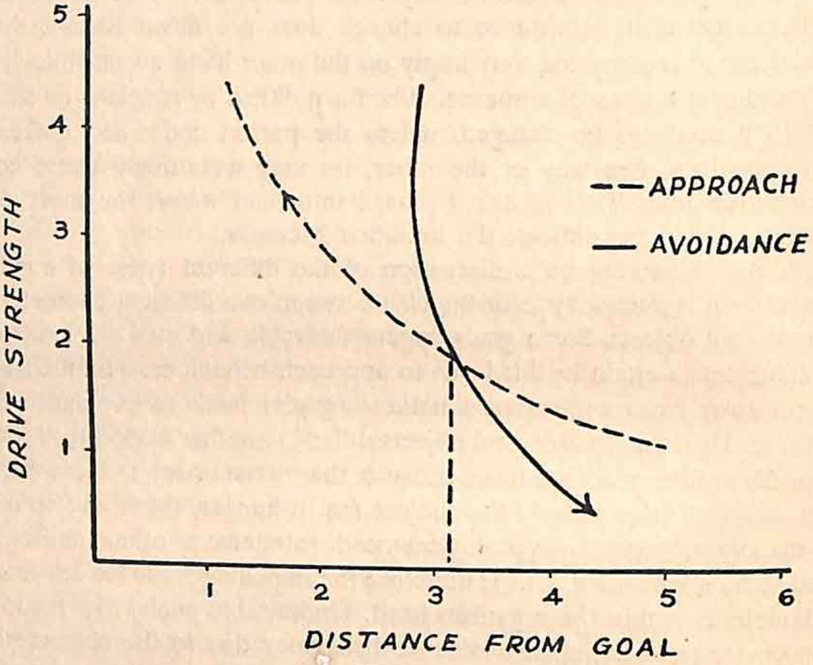


FIG. 18

When the goal is either attractive or unattractive, there is really no conflict involved provided the subject is free to move towards or away from it. But examine the following situation which is not so simple. If the subject is placed in the middle of two equally attractive goals, there would be a period of conflict due to indecision as to which one should be chosen. But this conflict is not insoluble because the equal attraction towards both holds good only when the subject is exactly in the middle. His least movement in one direction tips the scale in favour of the goal which is now a little bit nearer than the other. Sometimes it may even be possible to attain one goal first and then the other.

Now about a situation in which a subject is in the middle of two equally noxious stimuli. Here we must make an important alteration in the experimental set-up in that the subject must be restrained from moving in any other direction except towards or away from each of the noxious stimuli; otherwise the subject's tendency would be to approach neither but move in a direction at right angles to both. This would represent an insoluble conflict situation. Any movement towards either of the goals would bring it nearer and initiate avoidance behaviour. It is, therefore, reasonable to predict that no movement in either direction would be possible in that situation. Again, Miller corroborated the truth of this hypothesis as a result of experiments using rat subjects.

There can also be a situation in which a goal has ambivalent characteristics when it appears pleasant as well as unpleasant. This can cause an insoluble conflict situation in so far as that particular goal is concerned. If in the training of a rat, a particular spot in a runway has been associated with food and also with an electric shock, when it is placed far away from the spot, it will approach the food rapidly because at a distance the approach tendency is more powerful. But on coming nearer the avoidance tendency will also gradually build up. It is possible that at a particular distance from the goal the avoidance tendency will be equal to the tendency to approach. Any further approach behaviour will rapidly tilt the equilibrium in favour of avoidance because the latter has a steeper gradient and builds up more rapidly close to the noxious stimulus. So the animal would go back a little distance when the approach tendency would show a superiority. It would thus be unable to go forward beyond a particular radius from the ambivalent stimulus. This would then represent the point of equilibrium. Kurt Lewin demonstrated circling behaviour in very young children when they were confronted with such stimuli as for instance a box of chocolates which the children were forbidden to touch or an interesting animal which might bite.

Sherrington made an interesting study of physiological conflicts between rival reflexes. There is a saddle-shaped arch on a dog's back which when touched, causes the dog to scratch with the left foot if the left side of this area is stimulated and vice versa. The reflex movement is one of flexion of the foot. There is another reflex which can cause the left foot to be extended when the right paw is stimulated. Using a spinal dog (a dog whose brain has been severed at the level of the spinal cord) for his experiments, Sherrington stimulated simultaneously the right paw and the left side of the saddle-shaped area on its back. Thus both the extensor reflex and the flexion reflex of the left foot should have a tendency to be elicited. But in actual practice, Sherrington found that only one reflex was effective, the scratch reflex being usually inhibited.

REWARD AND PUNISHMENT

A reward, in Thorndike's terminology, is a satisfying state of affairs which an animal would like to continue or to seek out. For a reward to be effective there must be a drive state in the animal which would be reduced. Thus food and water act as rewards because they reduce or relieve the hunger and thirst states respectively; it is not that hunger and thirst are pleasant sensations by themselves. Extending this idea a little further, we may also say that the termination of an unpleasant stimulus can act as a reward.

Punishment can also be administered in two ways. If an animal shows a pattern of behaviour which is not the one required in a situation, a noxious stimulus could be introduced, the experimenter hoping that the resulting unpleasant state of affairs would impel the animal not to repeat the act which was punished. In this case the associationists would say that a direct link has been established between responding in a particular fashion and the punishment. But there could also be a situation in which if the animal did the wrong thing (from the experimenter's point of view) it receives punishment whereas if it performed the correct response, it could avoid punishment. For instance, the sounding of a buzzer could be the signal for a heavy shock on the foreleg of a dog which is strapped to a harness so that one of its forelegs is resting on an electrifiable grill. During the first few trials before conditioning is established, the dog would get shocked at every trial and then only raise its paw to escape the shock. But later, the onset of the buzzer would make the dog raise its paw and thus avoid getting shocked at all. An animal which has once learned this pattern of avoidance behaviour will continue to respond in a similar fashion even though the shock may have been discontinued by the experimenter.

In anthropomorphic terms one could explain this behaviour by saying that the dog "knows" that the buzzer is the signal for the shock to follow and in expectation raises its paw. But for scientific theorization it is necessary that some sort of connection is established between the paw-lifting act and the punishment (shock). In the example given above, since the dog escapes punishment by lifting its paw, how can there be a relationship between paw lifting and a shock which does not occur? Learning theorists have got round this difficulty by evoking secondary drives. Anxiety is often treated as a secondary drive and its operation in strengthening avoidance learning as the one described above, may be explained something like this. Shock is the primary drive in this case which impels the dog to raise its paw but there is also another stimulus which had been associated with shock and that is the buzzer. After a few pairings of buzzer and shock, the animal shows all signs of anxiety as soon as the buzzer sounds. So the pattern becomes buzzer-anxiety-shock. Finally when the paw-lifting response occurs without fail, anxiety remains. Since anxiety is associated with a situation in which shock has occurred in the past, the buzzer now becomes a signal for evocation of anxiety. So, in so far as anxiety is engendered on the sounding of the buzzer, paw-lifting would occur invariably. Such anxiety produced responses are very difficult to get rid of because the organism does not test the reality of the situation but avoids it altogether. This finds a parallel in human behaviour too. Some of the neurotic fears which plague the lives of innumerable human beings are thus kept alive probably because the people concerned completely avoid the situations which evoke the fears.

SUBCONSCIOUS CONFLICT

In the examples of conflict situations described in the earlier parts of this chapter, the person involved is usually aware of the rival factions warring for mastery. However, there can also be conflicts at the subconscious level and these are usually referred to as endopsychic conflicts. If the Id as envisaged by Freud is a seething mass of repressed desires and wishes, it is quite reasonable to assume that many of these elements may have nothing in common except their state of banishment from awareness. Endopsychic conflicts even though they do not become conscious, draw a great deal of nervous energy which could otherwise be used for creative activities. Not only do such subconscious conflicts cause vague, indefinable feelings of anxiety, they may also cause unpleasant dreams. It is now granted by most psychologists that the unconscious part of our mind has a great deal to do with the direction of our thoughts and actions; and that is why the psychoanalytical method of therapy insists that all repressions be brought to consciousness before cures can be effected. When the subject realises how he had been influenced by events which happened long ago and therefore can have no relevance to present behaviour, abreaction takes place with satisfactory resolution of conflicts.

A chapter on conflict would be incomplete without a reference to the Freudian theory of repression. So, here is a brief account of it. Freud thought of the mind as having two different levels—the conscious and the unconscious—both of which form a continuum. Thoughts and ideas may pass more easily from the conscious to the unconscious than in the opposite direction. Once in the unconscious, the re-entry of these elements into consciousness is barred by a censor which can be identified as the conscience or in Freudian language the super-ego. The role of the censor is to examine carefully all the unconscious ideas striving for entry into consciousness; usually its vigilance cannot be eluded but some repressed elements in the unconscious make use of various disguises to get past the censor. It is usually presumed that during sleep the censor is not active and then subconscious elements thrust themselves into awareness as dreams. Even then the unconscious elements in their true forms are rarely presented in dreams; first of all there is *condensation* in which a long episode extending sometimes over a period of months may be presented in the space of a few minutes. In the phenomenon of *displacement* there is a shift in emphasis from the really important aspect to the comparatively unimportant item, this being a cunning way of disguising the real intentions. Dreams are made interesting and full of action due to a third mechanism called *dramatization* which represents the events as a play enabling the dreamer to adopt an objective attitude when watching the pictures pass before his eyes as on a stage. Finally, the operation of *symbolization* ensures that elements are not presented in their true form but are represented by appropriate symbols. An example of such high symbolism is seen in Joseph's dream of the sun, moon and the eleven stars, described in the Bible. Sometimes the symbolism is a bit confusing because some authorities on the subject assert that the same item may be represented by different symbols. Thus it is clear that any dream can have two aspects; one is the *manifest content*, the actual material present in the dream, which by no means represents the true picture. By interpreting the manifest dream one arrives at its *latent content*. Some dreams are vividly remembered on waking but others which are only vaguely remembered undergo a further process called *secondary elaboration* which is really a kind of reconstructive activity. Due to all these factors, dream analysis is not a straightforward procedure but is full of the most elaborate interpretation and after all this one can never be quite sure whether the explanation is correct.

This would perhaps be a good place to introduce an explanation about repression. An idea is said to be repressed when it is summarily dismissed from consciousness even before it has had a chance to come into complete awareness. The ego, due to some vague indefinable fear, does not wish to recognise the particular idea as an item of conscious thought. This process is quite different from that involved in suppression in which the ego is fully seized of the implications of the idea and banishes it after fully assessing its merits. A repressed idea is a charged, dynamic particle which has merely gone underground whereas a suppressed one is a spent force the banishment of which is final.

However, there are a number of inconsistencies in the picture presented by Freud. One instance is the function of the super-ego which censors the repressed ideas. If that is its function, surely it should be aware of the nature and content of such items. Why the ego then does not also become aware of them is hard to explain. After all, according to conventional psychoanalytical theory the Super-ego is a projection of the ego.

On the other hand many of the implications of the psychoanalytical theory which relate to the every day life of human beings are quite convincing. For instance when people forget to post a letter or to keep an important engagement it is not just accidental but there may be a strong subconscious motive which effectively inhibits the recall of the relevant operation to be performed. Other phenomena which stem from the same source are slips of the tongue and stammering. When the repressed, often highly emotional experiences are brought to consciousness by psychoanalysis, stammering very often ceases. Sometimes the forces of repression are victorious over the personality of the individual and then somnabulism occurs. This and various types of mannerisms also belong to this category and too much of daydreaming or moodiness is often an effort to avoid external conflicts by escaping into the realm of fantasy.

Selye took up an entirely new approach to the problem when he tried to relate various psychological stresses and strains to many physical conditions. Even certain deprivations like those of food and elementary comforts may lead to sicknesses which may not have much physical basis apart from their being the resultants of psychological frustrations.

Selye found evidence to suggest that arthritis, hypertension and peptic ulcer (to quote just a few) are psychogenic in character having their genesis in some strong stresses and frustrations. Many writers who specialize in the nature of worry, give instances of how these three illnesses mentioned above may quickly overtake a chronic worrier. These conditions are the result of visceral reactions to emotional stimuli. The total functioning of the nervous system may be thought of as being aimed at maintaining conditions within the organism in a constant state. This is achieved by the division of the nervous system into two parts, the autonomous and the voluntary, the former being responsible for the internal vegetative process of the organism and the latter for the regulation of relations with the external world. The autonomic nervous system itself is divided into the sympathetic and parasympathetic systems each with opposing effects. The sympathetic nervous system mobilises the resources of the body for fight or flight by stimulating the heart and lung action, raising the blood pressure, making a good supply of carbohydrates available and by increasing the production of adrenalin. At the same time the functions of the parasympathetic system such as digestive activity and the storage of sugar in the liver are suppressed. For short periods such mobilization of energy helps one to cope with critical situations. But abnormal worry or a state of constant fear will only perpetuate the readiness of the body for fighting when there is no real need. Thus anabolism will be disrupted and there may be an abnormally large output of adrenalin which in turn may cause the pancreas to produce more insulin to cope with the increased sugar metabolism. Once the chemical balance of the body is disturbed, this may cause aggravation of certain mental attitudes which, in turn, increase still further the hormonal imbalance. Thus a vicious circle is established. Selye's contention that any strong emotion is a stress is borne out by observation in everyday life. People have been known to drop dead after a spell of wild anger, and worry has been known to cause angina pectoris. The very prevalent headache and the feeling of being a degree under, are common instances of indispositions caused by the stresses and strains of life.

Finally it has to be emphasized that conflict instead of denoting an aberrant personality is the heritage of every thinking man. Normality or otherwise of an individual undergoing stress is determined more by the quality and the intensity of his reactions to such conflict situations.

CHAPTER NINE

Mental Illness

THE concept of mental illness has undergone a great deal of change during the past fifty years or so. Not so very long ago, people suffering from such illnesses were looked upon as demon-possessed and therefore as being far below the level of civilized human beings; and the treatment meted out to them, at least in western societies, consisted of flogging, torture and purging. Nowadays popular opinion is not only tolerant but also enlightened, with the result that in institutions established for the care and therapy of these unfortunate people, patients receive the best of attention, wholesome food and congenial living quarters. This change in outlook has become possible because everyone realizes now that mental abnormality is a sickness and is neither possession by a demon nor malingering.

Out of all contributory causes of mental sickness, heredity and stress are the most important. Very often when the family tree of an individual showing abnormality is traced back, it is found that many of his forbears have had the predisposition towards mental illness. Sometimes an abnormal trait may manifest itself suddenly after remaining recessive (dormant) for many generations. The role of heredity is usually studied by observing identical twins; if one twin shows any disposition to develop a particular type of mental illness it is found that the other one also shows the same trait despite any variations in his immediate physical environment.

While heredity remains a predisposing cause, the stress and strain of ordinary living takes a heavy toll in terms of mental illnesses especially in societies with a high degree of sophistication and high living standards, in which the individual man has many things to worry about. The major conflicts arise over a man's relation to other people and the successful adaptation of his own inclinations so as not to clash with those of other people. In the impersonal atmosphere of modern society, each individual seems to be assigned to a colourless existence in which his hankering for importance and search for power often receive rude setbacks. The worries consequent on these frustrations may be contributory causes to a breakdown of healthy mental functioning, many people however being able to tolerate these over very long periods. But heredity as also other physical causes such as illnesses or injury may cause some people to reach their upper limit of tolerance sooner than others. The contributory factors are usually so very interrelated and complex that very often it may be very difficult to untangle the individual causes. Certain stages in life which mark particular physical developments or changes—as, for instance, the onset of puberty in children and the menopause in women—are periods of high physical strain. Senility causes a great amount of mental decline and is therefore another period in which there appears to be a greater susceptibility to mental illnesses.

Apart from these crucial phases in the life of an individual, chemical imbalance in the body may be a contributory cause. This imbalance can be caused by toxins which are by products of infections like syphilis or by the habitual use of drugs; sometimes also by alcohol. Mild attacks of delerium have also been known to occur in illnesses like typhoid and pneumonia. Any organic defect in the body or abnormal functioning of the endocrine system may hasten the onset of mental disease. It has also been observed that the deficiency of vitamins of the B-group in the intake of food produces certain marked symptoms though this state can easily be remedied by administration of the deficient vitamin. Any emotional disturbance which is sustained over long periods of time may be another contributory factor. And finally mental illness can be caused by some organic disease of the brain, like a tumour.

CLASSIFICATION OF MENTAL ILLNESSES

In recent times, two broad divisions of mental illnesses have been accepted. These are the psychoses and the neuroses. Psychoses are the major illnesses of the mind arising, it is thought, from constitutional causes probably due to obscure organic defects or actual damage to the brain. Diseases involving hallucinations and delusions may be classed as psychoses while anxiety states leading sometimes to irrational fear may be said to be neuroses. However, it must be noted that no hard and fast rules are operative regarding such dichotomy. Not only are the definitions open to more than one interpretation but it is found that even experienced specialists in the field of mental illness find it difficult on occasion to determine under which class a particular patient is to be included. So we must treat these broad divisions as a convenient rather than a rigid yardstick. But the basic difference between the psychoses and neuroses depends on the fact that in the former, the patient loses contact with reality whereas in the latter there is only a disorder in the functioning of the emotions and intellect. The organic bases for psychotic illnesses have not been proved conclusively.

There are further subdivisions under the two main categories mentioned above. While there are slightly differing terminology to denote these, one of the clearest is due to Adolf Meyer which is widely accepted at the present time. Meyer classified mental illnesses according to the reactions shown by the individuals who suffer from them.

Psychoses:

1. Affective Reaction Types
    (*a*) Manic depressive illness
    (*b*) Involutional melancholia
2. Schizophrenia
3. Paranoid Reaction Types
4. Organic Reaction Types
    (*a*) Acute
    (*b*) Chronic

Neuroses:

1. Anxiety States
2. Hysteria
3. Obsessive-Compulsive States

Psychoses:

Manic-Depressive Illness: The body type associated with this illness is the Pyknic one and the personality type is the Cycloid. The outstanding characteristics of this illness are the rapid mood-wings which make the patient to be elated and on the crest of happiness at one moment and be plunged into the depths of despair in the next. In the elated, violently energetic phase known as the Manic state, the subject speaks very rapidly but his speech may be completely coherent and intelligible although the flight of ideas may be fantastic. He may then appear extremely cheerful and feel that he can do things much better than anyone else. In sexual matters a certain lack of inhibition may be evinced. Sometimes, in acute cases of mania the patient may become violent and attack those who care for him. Delusions are also quite common, the patient thinking of himself as a king or a great man. The sustained overactivity present in the manic phase finally results in insomnia and complete exhaustion. Another striking characteristic of this phase is the total lack of insight into his own condition in that the patient has no idea at all that he is ill.

The depressive state may range from simple depression to stupor in which physical activity is slowed down resulting in complete apathy, and speech may be confined to monosyllables. Very often a great deal of self-reproach is evident which causes the patient to attempt suicide. Nihilistic delusions, a sense of unreality and lack of contact with reality are the usual symptoms of the depressive phase of this illness. The abnormal sense of self-reproach makes these patients a potential suicide risk.

It has been found that the manic-depressive illness occurs usually late in life, often after the fortieth year.

Involutional Melancholia: The onset of this disease occurs in the involutional period of life—from 50 to 60 years of age. Feelings of fear and anxiety are very marked, hypochondriacal delusions with nihilistic delusions are often present, and attempts at suicide consequent on the presence of abnormal self-reproach are very frequent. The patient refuses to look after his simplest needs and requires full-time attention.

Schizophrenia: Originally known as dementia praecox, this disease was renamed by Bleuler as schizophrenia which actually means split personality. In the majority of cases, Schizophrenia starts during puberty and the type of personality most susceptible to this disease is the schizoid type characterized by extreme introversion. There are four main types of schizophrenia—simple, hebephrenic, catatonic and paranoid.

Schizophrenia is characterized by loss of affect and by emotional inadequacy. Feelings of joy and sorrow may be absent and sometimes considerable incongruity of affect may be shown, such as for example laughter on hearing a piece of sad news and weeping when joyful news is received. Conversation becomes erratic with contradictory ideas in consciousness. Auditory hallucinations are very common in this condition, the voices heard being often extremely abusive. Sometimes these patients attack those around them acting on specific instructions to that effect from the voices. Visual hallucinations consisting of extremely vivid visions are also very common. Patients have also constant ideas that other people are talking about them and plotting their downfall which characteristic is known as ideas of reference. Delusions both of grandeur and of persecution are almost always present. Stereotypy, the useless repetition of movements or speech, negativism, acting contrary to instructions and the automatic obedience to any irrelevant instructions in the environment are other characteristics shown by patients suffering from this disease. Insight into one's condition is almost always completely absent. In the catatonic state either excitement or stupor may predominate; in the stuporose condition the patient is quite incapable of taking care of himself.

In the paranoid type of schizophrenia which develops later in life than at puberty, there are delusions of persecution and also hallucinations.

Paranoia: Paranoia is different from the Paranoid Reaction type referred to, in that the former does not show any intellectual deterioration, the patient being in full possession of his faculties though obsessed by delusions about his mission in life. People suffering from mild paranoia may go through life passing off as eccentrics; a school of informed opinion holds that religious fanatics and political assassins belong to this category.

Organic Reaction Types: Acute illnesses like delirium and the presence of toxic substances in the brain tissues do not constitute histological damage but in chronic reaction types nervous tissues may undergo progressive degeneration. Delirium present in certain fevers like typhoid, influenza and pneumonia may take the form of terrifying hallucinations, which may rack the patient. And although delirium causes violent activity it may last only for a short time, leaving the patient limp and exhausted. Occasionally, when a patient goes into a coma it could become dangerous and death ensues.

Epilepsy: Though the exact etiology of epilepsy is not clear, EEG records taken during attacks seem to indicate that there is abnormal electrical activity in the brain at that time. Among the chronic reaction types epilepsy is fairly common. It is characterized by periodic and repeated convulsive fits and its onset occurs fairly early in life. In the severe type of epileptic fit known as the "grand mal" the patient very often has adequate warning of an imminent attack; this awareness is known as the "aura". During the attack, he loses consciousness falling to the ground with a cry; the muscles become rigid, later causing jerky movements. There is also frothing at the mouth. This violent state usually gives way to sleep and on waking in the normal way the patient would show no awareness of what happened during the attack. In the milder type of epilepsy known as "petit mal" there is only a momentary loss of consciousness and many sufferers as also other people around them may not realize that these are epileptic attacks.

PSYCHO-NEUROSES

Anxiety States: Anxiety is a very familiar emotion. Many people live with it and also learn to keep it within tolerable limits; but a few are not successful in this and undergo what is popularly known as a 'nervous breakdown'. The outstanding symptom in all these sicknesses is fear with consequent rise in the secretion of adrenalin. Irritability may be marked, the ability to concentrate falls away rapidly and sleep becomes fitful being also marred by frightening nightmares. This state of anxiety seems to be a conditioned reflex and is brought on by the presence of a special stimulus or event. There is the case of the girl who experienced intense distress and anxiety on hearing church bells; under analysis it was revealed that at the moment of her mother's death a peal of bells had rung out and ever since then the girl had had her attacks of anxiety. In acute cases of such anxiety the sufferer may not only rush around in panic wringing his hands but he may also get sensitized to such an extent that the least noise would make him jump.

Hysteria: The word "hysteria" is itself derived from a word meaning "womb" because it was thought for a long time that only women would suffer from it. It is now known that men also may suffer from it though not to the same extent as women. The hysterical type of personality is immature in the extreme and emotionally unstable. The mechanics of hysteria are rather complicated in that it originates as a subconscious conflict between a forbidden wish and the need to conform to social conventions. The result of this endopsychic conflict manifests itself as physical symptoms which most often and in an indirect way gratify the wish. As the conflict occurs subconsciously the patient would be quite oblivious of it and therefore unable to explain his symptoms or his peculiar behaviour.

Paralysis of any part of the body or motor symptoms like tics, spasms and tremors are due to hysteria. Sometimes parts of the body lose their feeling which phenomenon is known as anaesthesia. Glove anaesthesia is the loss of feeling of the hand, stocking anaesthesia that of the leg. Hysterical blindness and vomitting respectively are common enough among hysterical patients; and in some rare cases spontaneous blisters and weals appear on the skin which phenomenon is known as *dermatographia.*

Amnesia: In times of war, cases of amnesia have been found among soldiers. Those who suffer from amnesia usually experience conflicts between actual fear normally present under battle conditions and the need to conform to the accepted standards of courageous behaviour. Fugues are acute attacks of amnesia in which persons wander about for days, months or years having no memory of their early life or even of their names.

Dissociation is said to have taken place when two or more personalities manifest themselves in the same individual somewhat in the fashion of Dr. Jekyll and Mr. Hyde. One of the most celebrated cases of dissociation has been described by Morton Prince. Miss Beuchamp was brought to Prince for treatment of her peculiar behaviour which was at the time attributed to severe neurosis. When the usual methods of psychotherapy proved to be of no avail, Prince hypnotised her inducing deep somnabulism without much difficulty. Under hypnosis a second personality known as B-2 emerged. Later on also under hypnosis another personality B-3 became evident. Whereas B-1 (the waking personality) had no memory of the activities of B-2 or B-3, these last two shared the memories of B-1. B-3 in addition knew also everything about B-2. Of the three personalities B-3 was a mischievous and destructive entity which often used to place Miss Beauchamp in compromising situations and withdraw leaving B-1 to cope with them. Finally, another personality B-4 also emerged before Prince was able to achieve some integration of all these personalities. In cases of dissociation one personality may be aware of the presence of the others or they may be mutually amnesic. Somnabulism or sleep-walking as it is popularly called, is another type of dissociation occurring during sleep or under deep hypnosis. Most often hysterical symptoms can be cured by psychotherapy but unless the underlying conflict is completely resolved, there is the danger of other symptoms breaking out.

Obsessional States: Obsessions are ideas and thoughts which present themselves again and again to the subjects' consciousness. These thoughts which are of no constructive use to the person concerned may sometimes be extremely silly and often blasphemous in nature. Counting or repeating of complicated figures is common in some forms of obsessions. On the whole, they constitute a hindrance to the even tenor of life.

Then there are the obsessional impulses or compulsive acts. For example, some people feel impelled to touch all lamp-posts they come across, to read every sign they pass and so on. These compulsive acts may be very simple ones or they may be highly ritualistic in nature. Sometimes compulsive acts can also be anti-social although the person concerned cannot help but do them. Pyromania, the impulse to set fire to barns, houses or hayricks is a fairly representative type of compulsive action and kleptomania, the impulse to steal things that one has no use for, is sometimes found in quite well-do-do people.

Obsessional fears known as phobias are also very common. Examples of some of these phobias which can be defined as irrational fears are:

Agorophobia	Fear of open spaces
Acrophobia	Fear of heights
Claustrophobia	Fear of closed spaces
Hematophobia	Fear of seeing blood
Mysophobia	Fear of dirt or pollution
Neophobia	Fear of anything new
Phobophobia	Fear of being afraid
Photophobia	Fear of light
Pyrophobia	Fear of fire
Symbolophobia	Fear that every action has a symbolic or hidden meaning.
Xenophobia	Fear of strangers.

PERSONALITY TYPES AND MENTAL ILLNESS

Clinical observations of a large number of mental patients seem to disclose some kind of inter-relationship among physical types, personality types and the type of mental illness that goes with these.

(1) *The Cycloid Personality*: The physical characteristics which belong to this type of personality are a plumpy body with rounded contours usually associated with the pyknic constitution. A person having the cycloid personality is extroverted, extremely sociable in outlook and is usually of a cheerful disposition. He is not a thinker and rarely broods or worries about things in general. His interests lie outside of himself, in meeting people, going to places, and generally making his personality felt in social intercourse. This type of individual if he succumbs to mental illness, suffers from what has already been described as Manic-Depressive illness.

(2) *The Schizoid Type*: People who possess long, thin and angular

body structure known as the leptosomatic body type are usually the Schizoid personality type. An individual belonging to this type is highly introverted, usually shy and shuns contact with other people. He likes to live in his world of thoughts and sometimes too much of introversion may be a pre-disposing cause for chronic states of worry and anxiety. Often the introvert also suffers from feelings of inferiority which further aggravate his withdrawal from contact with others and result in failure to adjust himself to the people around him. This personality type may be susceptible to schizophrenia.

(3) *The Hysterical Type*: The hysterical type of personality is characterized by superficiality of affect and a lack of deep emotions. A person having these traits may easily change, flitting from one interest to another and lacking constancy in affections. He may often be an opportunist, untruthful and unreliable even in very intimate personal relationships and with his best friends. This type of personality is liable to suffer from hysteria if he ever is in a situation likely to bring on mental illness.

(4) *The Obsessional Personality*: This type of personality is characterized by excessive neatness, meticulous care about minute details and undue caution. An individual possessing these traits will be over-conscientious in his work and likes to have his surroundings spruce and clean. He goes to great pains to check again and again anything he may do and hates to see anything out of its place. The arriving at a decision could be a painful affair for such a person because he feels compelled to weigh the pros and cons interminably. Slight hypochondriacal tendencies are also evident sometimes. The obsessional person, if he contracts mental illness, is liable to suffer from obsessional neuroses marked by compulsive states.

(5) *The Paronoid Personality*: An over-sensitive person ready to take offence at the most innocuous remark belongs to this type. Being very touchy he feels not only aggrieved at the actions of others but also suspicious of their motives. He reads meanings into everything that other people say or do; being usually conceited, he feels slighted if other people do not make much of him. This type of personality is susceptible to paranoic symptoms and delusions. However, paranoic symptoms may also be caused by prolonged physical discomfort, deafness, alcoholism, drug addiction and menopausal upsets.

FORMS OF TREATMENT

The treatment of mental diseases may take many forms, sometimes purely physical therapy may be enough to effect a cure. In other cases psychotherapy by itself or in conjunction with conventional therapy may be necessary. The following paragraphs will give an outline of the treatment available at the present time.

(1) *Insulin Therapy*: Insulin is a hormone which is essential for carbohydrate metabolism. In the disease known as diabetes the degeneration of the insulin-producing cells of the pancreas causes a breakdown in the secretion of insulin with consequent increase in blood sugar level. Daily injections of insulin are necessary to keep a diabetic in condition but the dosage of these injections is quite small. In insulin therapy for mental illnesses, large doses are administered, the idea being that the sudden reduction of the blood sugar level would cause a state of shock. After the required period of shock, the patient can be revived by giving him a sugar-rich food or drink which quickly restores the blood-sugar level. This treatment was first used by Sakel in Vienna and is now widely used in therapy for people suffering from Schizophrenia.

(2) *Convulsive Therapy*: The method of artificially producing convulsions in patients suffering from illnesses of the mind was first used by Von Meduna who used to administer camphor-in-oil injections to induce fits. Later electro-convulsive treatment (E.C.T.) came to be used widely. At each shock lasting only for a fraction of a second, convulsions take place whereupon the current is switched off. This treatment is most effective for people suffering from involutional melancholia and also for some schizophrenics. Recent statistics indicate that E.C.T. is much more the common method of therapy for patients belonging to the middle income groups in the U.S.A. The patients in the upper income groups presumably consider psychoanalytical treatment as more fashionable.

(3) *Electronarcosis*: This is a method of producing cortical inhibition by the passage of an electric current through electrodes applied to the temple. As soon as the required current is turned on, the patient goes into a stuporose state in which the pulse rate drops very low and respiration sometimes appears to stop. Narcosis or a state of deep sleep can also be induced by drugs like somnifaine and sodium amytal. This method of continuous narcosis is used with profit on disturbed, restless patients as in mania and on those with acute anxiety neuroses.

(4) *Carbon Dioxide Therapy*: This method has recently been introduced. In this type of therapy the patient is made to breathe a mixture of gases containing 30 per cent of carbon dioxide and 70 of oxygen until breathing almost stops whereupon the treatment is stopped. This method is very useful in anxiety states with hysterical features.

(5) *Pre-frontal Leucotomy* (*Lobectomy*): This kind of operation is based on the fact that impulses for the excitation of fear originate in the frontal lobes of the brain. It consists in cutting part of the nerve tracts connecting the frontal lobes to the Thalamic region, the idea being to prevent impulses originating at the frontal lobes from reaching the thalamus. Sometimes large areas of the frontal lobes outside the motor area are extirpated. However, the damage caused by this operation is irreparable because cut nerve fibres of the brain do not regenerate. But the effect is to lessen anxiety in pathological anxiety states and to reduce the violence in manic-depressive patients. Schizophrenics who are noisy, incontinent and dirty improve a great deal after pre-frontal lobectomy. But there is one evil effect consequent on this operation in that it removes the inhibition normally exercised by the frontal lobes; the patient becomes irresponsible with loss of consideration for other people.

Psychotherapy: Psychotherapy is not usually considered as an alternative to other methods of treatment described above, but there are some mental illnesses which respond better to psychological treatment. In most of these forms of psychotherapy an informal atmosphere is established whereby the patient attains a responsive state; and with the co-operation of the patient a general agreement is reached on the course of action suggested by the therapist. This understanding between the patient and the psychotherapist is usually referred to as rapport. It is very important for the patient to have a great deal of confidence in the psychotherapist and also in the mode of treatment suggested.

The application of suggestion is one of the simplest and most effective forms of treatment for the removal of psychosomatic illnesses, that is illnesses brought on by the action of the mind on the body. For instance, cases of conversion hysteria and local amnesia have been successfully treated by suggestion as demonstrated by Emile Coué in his Nancy Clinic. His method consisted of heterosuggestion to stimulate the patient's autosuggestion. Though Coue's methods do not enjoy great popularity at present, the basic principles of his therapy were quite sound.

Hypnosis is very widely used in modern therapeutics to effect cures not only of mental illnesses but also of psychosomatic illnesses. It is a valuable ally to a conscientious and careful therapist. The psychoanalysts claim however that hypnosis can be a dangerous tool in that sometimes only the symptoms may be cured by it without removal of the underlying causes unless a thorough course of hypno-analysis is undertaken. It is generally agreed that the absolute willingness and co-operation of the subject is required before he can be hypnotised. In some cases of mental illness, the induction of hypnosis becomes an impossibility due to the patient's lack of ability to concentrate on or understand the instructions of the therapist. Moreover not everybody can be hypnotised to the level required for therapy.

Psychoanalysis: The technique of psychoanalysis has already been described elsewhere in detail and so it will receive only a very brief treatment here. The disadvantage of this method is that it is time-consuming, each patient requiring months or even years before some results are obtained. On the other hand, sometimes the analyst may be able to unearth the underlying causes of conflict in a few sessions in which case rehabilitation can be undertaken immediately. Dream analysis is an important aspect of psychoanalysis. Another very important factor is that the subject undergoing psychoanalysis should be reasonably intelligent and co-operative.

To induce rapid results by getting the patient to talk freely, various drugs are sometimes intravenously administered. This procedure creates a condition of disinhibition in which the patient remembers details of his early life with greater clarity. Sodium amytal used to be extensively used for narco-analysis as this method is called. But recently LSD (Lysurgic Acid diethylamide) has been used with remarkable success. Under this drug a patient is able to recollect all the happenings of his life vividly sometimes from the time of his birth. These drugs quicken the process of locating the repressed incident thereby causing an abreaction and thus saving the analyst a great deal of time and labour.

Conditioning as a cure: Recently a great deal of criticism has been raised against the method of psychoanalysis by a number of leading psychologists among whom Eysenck has been quite outspoken.

He does not agree with the contention of Freudians that under some forms of behaviour therapy only the symptoms may be cured without the removal of the underlying complex whereupon other symptoms may emerge. Eysenck draws from his knowledge of several case histories and the follow-up studies to assert that this is not quite true. He also seems to think that as this particular point is central to psychoanalytic theory, its refutation must be regarded as a severe blow to the theoretical foundation of psychoanalysis.

Eysenck advocates the use of conditioning to establish a new habit in the place of the one which is to be eradicated. In many of the neurotic disorders as in anxiety states the trouble is due to a conditioned sympathetic reaction in which the body is kept in a state of readiness for fight or flight for long periods. This reaction then becomes conditioned as a habit and causes the neurotic symptoms. It is reasonable to suppose that the sympathetic conditioning can be got rid of by establishing a para-sympathetic conditioning to the same set of stimuli. The use of this counter-conditioning method is also advocated by J. Wolpe who terms it the method of "reciprocal inhibition".

Eysenck gives the following example for this method of therapy. In Watson's experiment to demonstrate conditioning in human beings a fear of furry animals was established in little Albert by causing a loud noise to be made whenever Albert attempted to touch his pet rabbit. To condition the appearance of furry animals (the stimulus in this case) to a para-sympathetic response, it would be necessary to introduce such animals when Albert was eating something. But a sudden introduction of a rabbit in such a situation would evoke only a sympathetic reaction with stoppage of digestive activities. To avoid this, the rabbit could be shown at a very great distance at which the sympathetic reaction is not elicited and at the same time Albert could be offered a sweet. Gradually in subsequent trials the rabbit could be brought nearer and nearer and in each trial with the rabbit present, Albert would be allowed to eat a sweet. Thus the para-sympathetic reaction of eating could be conditioned to the presence of the rabbit when the fear reactions (sympathetic reaction) originally present would be eliminated. Though this is a simplified account of what is possible, the method of conditioning seems to be an effective way of dealing with many neurotic disorders; and what is more, it is direct and less time-consuming than conventional psychoanalytical methods.

Group Therapy: Group therapy which works by suggestion and facilitation was practised by Coué in his Nancy clinic with great success; he would administer curative suggestions to a patient in the presence of all the others. Any small improvement noticed in the condition of this patient was observed to have a profound effect on the others who also became highly suggestible. In the conventional sessions of group therapy now in vogue, the therapist acts only as an observer giving advice and encouragement whenever necessary. The patients themselves discuss their difficulties and derive great encouragement in knowing that these problems are not exclusively theirs and that other people also have similar ones. The only precaution usually taken is to see that neurotic and psychotic individuals are not kept together in the same group. In the method known as psychodrama first introduced by Moreno, patients are allowed to play out the various roles in a family group on an improvised stage. The lines are made up on the spot and the acting would be a recapitulation of the events in the patient's life. The nursing and other staff in such institutions join in the drama and take the roles of the mother, father or other relatives of the patient. The patient himself has the opportunity to play the various roles and this procedure helps him to understand the points of view of other people. After the drama, the patients discuss the outstanding problem portrayed by the play and offer not only their solutions but also give their comments. During the discussion many of the patients usually feel that they have parted the veil a little and have understood a little more about how the human mind operates. Group consciousness also increases as a result of these discussions and play-acting.

In conclusion, it must be said that it is too sanguine to claim that any one of these methods—either physical or psychological—would by itself be a panacea for a particular type of mental illness. Judicious combination of suitable techniques depending not only on the nature of the illness but also on the needs of the individual patient may be necessary before any particular course of action is decided upon. Finally sympathy and insight are absolutely essential on the part of those who would minister to the mentally ill.

CHAPTER TEN

Schools Of Psychology

ASSOCIATIONISM

THE principle of associationism attempts to explain why memories of certain events are connected together so that when one such event is recalled, the others related to it are also brought to mind. Plato, who is credited with the earliest formulation of a definite theory of association, thought that one thing reminds us of another because the two things are either similar to each other or because they occurred together the first time they were apprehended, these two factors being known as similarity and contiguity respectively. Later, Aristotle added contrast also as another factor contributing towards successful association, but this formulation of associationism was more of a mechanical concept which was moreover violently opposed to the idea of a soul. All mental functions are more or less mechanistic, according to Aristotle, and experiences motivated specific parts of the brain so that if an idea occurred again, it would bring to mind a host of related ones.

Hobbes later elaborated on this and in an attempt to give a clearer picture of the process of association reduced everything to motion. External stimuli caused internal motions which persisted even after the stimuli ceased and these persisting internal motions constituted memory. Hobbes spoke of the various reasons for the association of memorial elements. According to him such association was due only to the fact that in the original experience these elements were connected together. However, he could not explain why the revival of one item should be followed by only one particular item out of many others. David Hume tried to explain association by applying the principle of cause and effect.

Thomas Brown, an ardent associationist, was the first to formulate definite laws as to how ideas tend to get related in the mind. He accepted as a basic principle the role of contiguity, similarity and contrast but emphasized clearly other factors like frequency, duration, vividness, recency and freedom from competing associations, as the characteristics required of the external stimuli. But subjective factors are also important. These consist of constitutional differences between individuals, the state of health of the individual at a given time and prior habits of life and thought. We can say that Brown's laws of association have stood the test of time and with very minor modifications are still accepted as laws defining efficient methods of learning. At the present time, however, we do not talk much about the association of ideas.

The doctrine of Redintegration advanced by Sir William Hamilton deserves mention here because it also deals with how association is largely responsible for the phenomena observed in recall. According to this theory a part or fragment of an experience, if presented again, brings back to our mind the whole memory of that experience. The ardent lover on perceiving the smell of a particular perfume, is reminded of his beloved and the sound of a bugle recalls to the mind of the soldier the alarums and excursions in which he has taken part.

Herbart had some very interesting contributions to make to the Association theory. He not only spoke of a struggle between various memory elements to come to the focus of consciousness but also formulated the idea of a threshold across which ideas appear and disappear. Though Herbart did not formulate a clear idea of the unconscious as Freud did later on, he did lay the foundation for the concept of conservation of ideas in the unconscious. His most important contribution is the postulation of an apperception mass. Each experience leaves an after-effect in the experiencing organism, and new experiences help to build a kind of pattern. Any future event is appraised in terms of this pattern already present and its after-effect is, in turn, incorporated into this already existing system known as the apperception mass. This theory has had far-reaching effects on education. There is no use in getting a learner to imbibe a lot of unconnected material by the method of rote learning; on the other hand the learner's mind should be previously prepared by building up a coherent and related apperception mass into which any new facts can be incorporated.

While associationism tended to evolve out of purely mechanistic interpretations, there were people like James Mill who emphasized the hedonistic aspect of associationism and reduced experience to an arithmetical sum total of individual sensory components. Hedonism is the principle which postulated that all of men's actions stem from the desire to achieve pleasure and to avoid unpleasure. James Mill could not accept the idea of a total experience having any other characteristics not present in the individual parts which go to make the whole experience. To give an analogy, this would be tantamount to saying that our idea of a house is only a sum of the ideas of the bricks, cement, wood and steel which go to build it. Yet John Stuart Mill, the son, was to propound the theory of mental chemistry which holds that an experience has more properties and some characteristically different properties than the mere sum of those of the components. This holistic approach had an instantaneous impact on the many schools of psychology many of which readily incorporated this idea in one form or the other.

William James sought to give a physiological explanation to the associationist theory. He argued that when two particular areas of the cortex were stimulated together, nervous energy would flow from one area to the other which would reduce the resistance of the particular pathway. Later, when one experience was revived, the other also would automatically rise into consciousness. However, James's comparison of the neural impulse to a mountain stream eroding its bed, thus wearing out a valley, is rather misleading because the operation of the nervous system is rather different.

Hitherto in the history of associationism, the theories remained largely hypothetical—no attempts having been made to present experimental evidence or to relate theoretical assumptions to experimental findings. With the experiments of Ebbinghaus using nonsense-syllables, a new era of associationist psychology was ushered in. The concept of memory span was introduced for the first time. Curves of learning and forgetting were plotted. Intra-serial bonds and facility of memorizing particular sections of a chain of words, were thoroughly investigated. As a result, definite laws of learning and memorizing were formulated. Nevertheless, in all these investigations, there was present an artificial element because the material used was only nonsense-syllables which constitute material far removed from anything that a person might be called upon to learn in real life. Not only that, there was no scope for the affective factor to make its influence felt in the learning of such neutral material.

The acceptance of Darwin's theory as a plausible explanation of observed facts, caused a great deal of change in the methods of experimentation of psychology. When it was realized that animals and men were not totally different beings and that their obvious differences were only those of degrees of development, experimentation with animals took on a different aspect. Lloyd Morgan's canon that ". . . in no case may we interpret an action as the outcome of a higher psychical faculty if it can be interpreted as the outcome of one which stands lower in the psychological scale" summed up the concepts current at the time regarding animal experimentation. This trend towards extreme simplification had its ill effects in that it led to an emphasis on the stereotypy of animal behaviour by experimentalists like Thorndike and others. Thorndike emphasised the role of trial and error in the performance of cats in opening puzzle boxes. As in the case of the associationism existing during the era of James Mill, Thorndike also was led to fall back on a theory of pleasure-unpleasure having direct effects on learning. He called it the law of effect. A particular type of response was stamped in if it produced pleasurable consequences and stamped out if it produced unpleasurable effects. The law of exercise with its sub-laws on disuse and recency, strove to explain the differential strengths of various associations. Thorndike also demonstrated the comparative effects of punishment and reward in the performance of human beings. He styled himself a "connectionist" because he believed in the strong associative connection between a stimulus and a response rather than one between two impressions. This brought out the importance of an active response to stimulii if bonds between them are to be strong.

Pavlov, a contemporary of Thorndike, was responsible for the theory of the conditioned reflex. His work on the salivary reflex of dogs to various stimuli, has been described in another chapter. The whole theory of conditioned reflex is concerned with demonstrating how a bond or association might be formed between the conditioned stimulus and an unconditioned response after the two had been paired for a number of trials. Soon after Pavlov's findings were published, it was thought that the conditioned reflex indicated the way by which all learning takes place. But there is no evidence to prove that such a sweeping generalization is justified. Skinner's demonstration of instrumental conditioning shows yet another way in which learning can take place. Here the animal has to learn to perform an action which is instrumental in producing the unconditioned stimulus. Extinction has also been demonstrated in instrumental conditioning, brought about by non-reinforcement.

Among those who sought to give a firm theoretical backing to the principle of association, Spearman's work on the laws of noegenesis merits mention. The first of these, the principle of eduction of relations, states: "The mentally presenting of any two or more characters (simple or complex) tends to evoke immediately a knowing of the relation between them". For example, if two qualities "bravery" and "cowardice" are presented, the mind immediately grasps the relationship of "oppositeness" between the two words.

The second principle, that of the eduction of correlates states that "the presenting of any character together with any relation tends to evoke immediately a knowing of the correlative character". Thus when the character—"bravery" and the relation "opposite" are presented together, the correlative character—"cowardice" will be immediately apprehended. There is a wide scope for the application of these laws.

The principle of association is one of the fundamental concepts of psychology and while no one denies its basic truth, it is the interpretations regarding its operation and applications which differ greatly.

THE PSYCHOANALYTICAL THEORY

Though the root of the psychoanalytic theory goes back to the principles of hypnotism first demonstrated, in the West, by Mesmer in 1780, it was Sigmund Freud (1856-1939) who worked out a comprehensive and intelligible theory of psychoanalysis. The concept of the unconscious dates back to Herbart who, it may be remembered, clearly spoke of the disappearance of ideas from consciousness and their reappearance across a threshold. Freud thought of the mind of man as having two aspects—the conscious and the unconscious. Objectionable ideas and desires which offend against propriety, are relegated to the unconscious whence their reappearance into consciousness is prevented by a censor exercising constant vigilance. The banished desires, nevertheless, are not disposed of permanently but are capable of making themselves felt. These constantly try to enter consciousness under different guises to fool the censor. Sometimes when the disguise is sufficiently ingenious, these ideas succeed in getting past the censor into consciousness. Particularly during dreams, the unconscious ideas and desires masquerade in a fantastic pattern. Freud clearly makes a distinction between the phenomena of suppression and the repression of an idea. When a volitional effort is made to get rid of an unwelcome thought or desire, suppression is said to take place. In repression, however, the ego is so shocked at the vileness of the desire that it is not allowed even to come into full awareness. A constant subconscious effort keeps this idea in the darkness of the unconscious. This is the mechanism of repression.

It is easy to see why a repressed idea should drain off nervous energy which thus becomes unavailable for other essential processes of life. Freud's concept of the operation of repression is important in many respects because it stresses the vital role that childhood impressions and mode of life play on the adult-life of the individual. A childhood full of repressions results in an unconscious that is a seething mass of elements constantly having to be kept under. When there occurs a weakness somewhere along the line, the flood of repressed thoughts begins to manifest its power in the life of the man. The unfortunate part of it is that the person himself is usually unable to understand what drives him to perform actions which he consciously does not want to do.

Freud's theory of the libido emphasizes the fact that the libido is the energy behind the sexual instinct and that it manifests itself early in the life of a young child. The child's first contact with the mother in the act of suckling gives it immense physical pleasure and satisfaction. This starts a very close relationship with the mother; the gentleness of the mother and the care which she lavishes on the child, strengthen this bond as against the stern discipline enforced by the father. The father thus becomes a symbol of authority with whom the child has to share the love of the mother. This leads to ambivalent feelings in the child towards the father. While this kind of hostility to the father might be a natural feeling in any child, an excessive attempt at discipline by the father invariably leads to an abnormal feeling of resentment and to the complex known as the Oedipus Complex—the simultaneous feelings of attachment to the mother and hatred towards the father. This complex develops in a boy and the corresponding one for a girl is the electra-complex, a feeling of love towards the father and hatred of the mother. But the etiology of the Electra-Complex is harder to explain.

In psychoanalytical language "conscience" is represented by the super-ego, which develops as a result of the ambivalent feelings of respect and hatred felt by the child towards the father. Recognising the authoritative role of the father, and also his position as the breadwinner in the family, the child learns to repress these hostile desires and ideas and accepts the image of the father as the standard. The super-ego thus developed decides which ideas are wholesome and which not, and consigns those which are not acceptable into the unconscious. The greater the ambivalence of the feelings developed by the child towards the father, the greater the inflexibility of the super-ego in the adult. More and more thoughts and ideas will have to be repressed, leaving the mental life of such an individual hopelessly impoverished. With such a rigid system of standards there is always the danger that the libido may not find expression through the usual channels. If it is denied forward expression, it regresses. That means that the individual reverts to a mode of behaviour common in an earlier stage of life—usually that of childhood. But there are other mechanisms which can solve the dilemma. The libido can be diverted into other acceptable channels and can sometimes result in great creative efforts as in music and painting; this channelling of the libido into approved paths is termed *sublimation* and can only occur when the mode of expression in both the activities is more or less similar. Sometimes the word sublimation is mistakenly used to mean the substitution of a socially accepted activity to replace another which is taboo. Thus an inordinately demanding sexual urge could be softened by turning to music or painting but it is doubtful whether the abnormal sexual propensity can be completely overcome, by this means.

The actual practice of psychoanalysis is based on the observations and findings described above. The patient is asked to relax in a completely permissive atmosphere from which all distracing stimuli are carefully excluded and then he is encouraged to talk about any and everything from the events that happened in the early years of life, while the analyst plies him with unobtrusive questions at long intervals to clarify some points. During the first few sessions, the descriptions of the patient, will seem interminable and leading nowhere. But all the same, the analyst might get an inkling as to the probable region of the conflict. When the first phase of the analysis is over and the patient finds that he has given away many of his innermost thoughts, a "resistance" to the continuance of the analysis manifests itself on the part of the patient. The analyst, with patience, insight, tact and sympathy, has to win over the patient's goodwill. Sometimes he has to do this even when the patient abuses him in unmistakable terms. Finally when the repression is unearthed and the patient given an insight into the causes of his neurosis, the task of rehabilitation takes place. Somewhere about this point comes the phenomenon known as "transference". The libidinal energy attaches itself to the analyst who finds himself in a peculiar position. But when the patient obtains insight into his own trouble, the major hurdle can be said to have been passed.

In the early days of psychoanalysis, Freud was very much in favour of the pleasure principle. This is actually an extension of the hedonistic doctrine that man's actions are directed towards the attainment of pleasure and the avoidance of unpleasure. Freud substantiated his doctrine by giving as evidence the contents of day-dreams and dreams during sleep. Day-dreams are an attempt to escape from reality into the world of phantasy. A person cannot indulge in enjoyment of uninhibited pleasure always because his search for pleasure might bring in its wake swift punishment when individual interests clash with the social interests. So the ego is compelled to abandon its pursuit of pleasure and to come down to reality. This acknowledgement of reality is known as the reality principle.

Freud was constantly evolving and modifying his theory not only to meet the constant stream of objections but also to adapt it to the findings disclosed in his clinical practice. He strove also to make some of his pronouncements clearer and his terminology less ambiguous. He explained schizophrenia as narcissism wherein the individual withdraws himself from external interests and concentrates his interests on his own self. This narcissism, which is abnormal in adulthood, is nevertheless a necessary stage in the development of all infants and is then termed primary narcissism. Freud was also led to make the theory of ambivalence all-embracing in its scope. He postulated the simultaneous presence of life and death instincts (Eros and Thanatos) operating in every individual and thus explained some of the abnormalities of behaviour like sadism, self-punishment and self-condemnation. The familiar feeling of jealousy is also an ambivalent emotion.

In his original theory of the unconscious, Freud thought of the conscious self (ego) as exercising a restraining influence on unconscious desires and preventing them from emerging into consciousness. But his experience with patients indicated the fact that this resistance itself was unconscious and beyond the awareness of the individual. Therefore he pictured the Ego as having two aspects, an unconscious one directly in touch with the unconscious Id (consisting primarily of drives, inherited instincts and urges) and the conscious one, in touch with external reality. In the early years of life, the ego is undeveloped and so the desires of the Id easily rise up into consciousness. Later, the ego learns to repress objectionable ideas and desires. All these repressed ideas add to the strength of the Id and make for a weak ego. That is why the conscious mastery of a desire is better, in the sense that it does not drive it into the unconscious to increase the strength of the Id. The need to conform to socially accepted patterns of behaviour and the swift punishment which follows non-conformity make the ego to split into two parts—the executive part (the real ego) which carries out various actions and the super-ego (conscience) which is the watchdog. The greater the severity of discipline the child is subjected to, the stronger and more inflexible the super-ego becomes. This, far from being a welcome development, impoverishes the personality in that no effectual action is possible.

Freud's psychological Seminar in Vienna flourished for a long time, with distinguished men flocking to him from far and near. But as the implications of the Psychoanalytic theory unfolded gradually, some of Freud's disciples could no longer profess loyalty to his doctrines. Among those who broke off to found their own brand of psychoanalytical theory and practice, Alfred Adler (1870-1937) established what is now known as Individual Psychology. He thought that an inordinately excessive stress was being laid by Freud on the sexuality of the child. Adler described the child as being motivated by a feeling of inferiority which arises first when the child finds himself surrounded by older people who could perform many skilled actions with facility. This develops an urge in the child to try to surpass his elders in achievement. He goes all out in his attempt to do something worthwhile to alleviate his sense of inferiority. Conflicts and consequent neuroses occur when the search for power by the individual clashes with the interests of other people. When the level of aspiration is too high, one is incessantly driven from within. Every child develops a "style of life" depending on the pattern of behaviour that he had accustomed himself to, from early life. A child's position in the family also affects his style of life. When the sights are adjusted too high and the individual falls short of achievement, various phobias and neuroses occur. Unlike Freud, Adler did not approve of a sexual basis for the appearance of conversion symptoms. The individual adopted these strategies in a bid for attention, seeking to obtain the attention of just those people whom he is out to impress. Sometimes an illness will make available the loving care of those around him, or perhaps some delinquent action would focus the attention of the world on him. Whatever the outcome of an individual's adjustment to society, it is always the result of a search for power and prestige. Whereas Freud insisted that dreams are a fulfilment of old wishes repressed in the subconscious mind, Adler thought they might be a rehearsal of decisions which the person concerned has to make, or of events to come. He also liked to interpret dreams as a whole, instead of analysing them into elements to be interpreted separately and finally putting them together again as Freud did. The slow, conventional methods of orthodox psychoanalysis with its long-drawn out sessions came under Adler's scathing fire. He was for the quick interview by a gifted analyst who has an ample share of intuition and insight. Adler himself was gifted this way and if his psychology appears superficial, it is probably because his intuitive approach to psychoanalysis made it difficult for him to convey his impressions in so many words.

Carl Gustav Jung disagreed with Freud on the aspect of the predominant sexuality of the libidinal energy. He thought that the libido was an expression of the whole vital energy of the individual, of which the sexual energy was but a part. The libido expressed itself in different forms at different stages of one's life. In very early childhood, it was concerned mostly with physical growth and nutrition. Jung differentiated between the predisposing cause and the exciting cause in the development of neurosis; the predisposing cause might be due to the accumulation of repressions and complexes in the unconscious. This, by itself, does not cause any neurosis if the individual's free expression of the libido is not blocked by extraneous circumstances. When such a blockage occurs, that would be the exciting cause and the individual harks back to that stage of development when the libido enjoyed an unhampered flow. This phenomenon is regression. Jung's concept is based on the classification of people into an extroversion-introversion dimension. In the extroverts, the energy of the libido is directed outwards and in introverts the energy is directed inwards. The direction of the abnormal mental states that people fall victims to, depend on whether they are introverts or extroverts. Within each of these divisions Jung recognised the thinking, feeling, sensation and intuition types, making altogether eight different classes of people. He recognised also two levels of the unconscious—the superficial layer known as the personal unconscious, and the deeper layer known as the collective unconscious. Whereas the personal unconscious develops during the life of the individual, the collective unconscious is given at birth and represents a quintessence of the personal unconscious of our forefathers extending back to the twilight of history. The collective unconscious includes the instincts and also the archetypes which are primitive ways of thinking. The system of instincts was referred to as "Id" by Freud and it determines the way of acting by an individual. Mythologies of the ancient civilizations, cut off as these civilizations were by physical barriers from intercourse with one another, show a remarkable similarity and Jung thinks this is due to the archetypes expressing the collective memories of the race. Reading through Jung's exposition of the collective unconscious, one sometimes wonders whether the evidence for reincarnation adduced by the protagonists of that doctrine, is not due to the presence of archetypes which, under some conditions of stimulation, spring into consciousness. Though Jung classified individuals into types, it does not mean that these types are mutually exclusive. Thus an introvert has extroverted characteristics present in the unconscious and vice versa. Men and women have "feminine" and "masculine" characteristics (traits) respectively hidden away in the depths of the unconscious. If only these latent characteristics could be brought to light, all individuals would develop fuller, richer personalities. How can complexes and unconscious problems be unearthed? Jung popularized the "word association tests". In this test, stimulus words are presented one by one and the subject has to respond with another word as quickly as possible. Unusual or repetitive responses are noted and the reaction times recorded. An undue delay in response evocation or inability to respond to a particular word, denotes emotional involvement. In another form of the association test, a stimulus word is presented and the subject asked to respond as quickly as possible with a string of words which spontaneously occurs to him. Speed of response should be insisted upon if spontaneous reactions are to be obtained.

Abram Kardiner (1939, 1945) and Erich Fromm (1941, 1947) repudiated the great stress placed by Freud on the individual and thought that greater emphasis should be placed on the individual's interaction with other members of society. Kardiner instituted the psychoanalytic approach in anthropological studies of cultures. The "basic personality" in one culture could thus be compared with that in another. He analysed the Tanala and Betsileo cultures on the island of Madagascar and showed how infants born into primary institutions, (*i.e.* family groups) and subjected to pressures from society, project secondary institutions like taboo systems, religion, rituals, folk tales and particular techniques of thinking. The degree and quality of discipline to which infants are subjected to in a given society, decide what type of personality would emerge in adulthood.

Karen Horney was another psychoanalyst who, while accepting some of the basic postulates of Freud, nevertheless struck out on her own and tried to practise psychoanalysis using methods unhampered by the strict restrictions that Freud imposed. According to her, repressed ideas in childhood, do not remain isolated but form a complex structure which, as a whole, influences adult behaviour. Horney explained neurosis as an escapist tendency from "basic anxiety". A child's attempts at fuller development follows a different channel if the original one is frustrated. Different ways are explored and only if all these come to naught that the child develops a neurotic personality. Horney emphasizes the need for assessment of the present conflicts in an individual and the necessity of coming to grips with them, rather than for delving into the dim past, to bring to light repressed desires of early childhood. The predominant sex drive and consequent social difficulties experienced by some people are not the basic causes of neurosis but are rather the results of a neurotic character. What Horney in fact tried to do was to clarify many aspects of psychoanalysis and to shift the emphasis from strait-jacket restrictions to a more liberal way of thinking.

BEHAVIOURISM

Animal experimentation had a large part to play in the emergence of Behaviourism as a psychological principle. Pavlov's experiments on the salivary conditioned reflex in dogs demonstrated the fact that a response could be "hitched" to a stimulus which, in the natural run of things would not initiate that particular response. Thus the ringing of a bell or the sounding of a metronome could be made to initiate salivation in a dog. Conditioned reflexes seemed to be the best explanation for the formation of simple habits. Bekhterev, another Russian physiologist, went a step further and outlined how even complex patterns of habits could be thought of as being built up from simple conditioned reflexes. He thought that most learning could be explained in terms of the establishment of the appropriate conditioned reflexes.

Just before and during this period, psychology was quite subjective in its outlook and methodology because introspection was the accepted way of experimentation. The "mentalistic" concept of psychology grew apace and it is no wonder that reaction to this philosophy set in and moved towards the other extreme. The conventional definition of psychology as the Science of the Mind, underwent a remarkable modification. McDougall was the first to re-define psychology as the science of behaviour, thus voicing the inauguration of the new trend.

At about this time (1924), J. B. Watson, professor at John Hopkins University in the U.S.A., decided to blaze a new trail in the light of the development of the biological approach to psychology. He was particularly disgusted with the undue emphasis laid on introspection. All psychological experimentation revolved around this nucleus though Titchner proved that the introspective method was fraught with many pitfalls and that no two introspectionists agreed perfectly on any point. Not only that, special and long training was necessary to turn out skilled operators in this line. This involved protracted labour and moreover the results did not justify it. Another fact is that, "mental processes" changed during the act of examination and it was difficult for a person to act both as an experimenter and subject simultaneously. Lloyd Morgan's cannon, that in interpreting the behaviour of an animal the simplest interpretation in preference to one at a higher level should be accepted, also served to emphasize the fact that complex mentalistic interpretations are not always the best. In animal studies, no introspection is possible and the experimenter has to base his findings only on the observable behaviour. Learning experiments produced many interesting findings, some of which were later applied to human beings. This was the background which confronted Watson when he undertook to found a new approach to psychology.

Behaviourism can be defined as that principle according to which the behaviour of an individual is objectively studied. It denies the existence not only of a mind that directs and controls the diverse behaviour patterns, but also of consciousness; the brain is not a mysterious entity performing a complex unfathomable function but only a relay station between the receptors and effectors. Watson spoke of two kinds of behaviour, explicit (overt) and implicit (covert) respectively. Implicit behaviour, though not readily recognizable, is nevertheless always present in a weak form. Take the processes of thought for example. They are only implicit speech. The child vocalizes a great deal but social pressure reduces these vocalizations to a whisper and finally to soundless speech. Watson claimed that given very sensitive instruments, these implicit speech movements could be easily demonstrated. Attempts were made towards this end and the apparatus designed for this purpose despite their crudity seemed to detect these speech movements during thought. Max and Jacobson showed that when subjects imagined movements in any part of the body, there was a sudden upsurge of electrical impulses (action currents) in that part. In deaf and dumb people action currents were produced at their finger tips during thought! (This is because the "speech" of the deaf and dumb people consists of a sign language with the fingers). These experiments, however, do not prove conclusively Watson's contentions about thought being implicit speech. To the behaviourists, thought processes are only implicit trial and error behaviour; but it is hard to see how they can explain creative thought processes.

According to Watson when a person reports on an external object, no conscious sensation is involved. He makes only a verbal response to the stimuli. If this were the case, it is hard to say what happens between the impact of the stimuli on the person's sense organ and his verbal report of it.

Though memory images are usually thought of as centrally aroused sensations directly accessible to introspection, Watson tried to prove that they are only sensorimotor processes. With regard to emotions, Watson's explanation runs on the lines of the James-Lange theory of emotional evocation. Emotion is a form of implicit behaviour manifested by glandular and visceral systems. Thorndike's original law of effect that satisfaction or unpleasure respectively connected with the outcome of a piece of behaviour determines its repetition or avoidance, did not appeal to Watson.

He demonstrated (perhaps for the first time) that a human being was as good a subject in conditioning experiments as Pavlov's dogs were. The establishment of fear conditioning in young Albert seemed to prove this. Watson held that there were only three inherited reactions, *viz*, love, fear and rage and that all other reactions were "learned" by a process of conditioning. The idea that all learning processes are really the establishment of conditioned reflexes was carried to further limits by E. B. Holt, who sought to prove that the meaning of a word is only a conditioned response to that word. When the word "toy" is spoken as a child reaches for that object, in time the child comes to connect the word with the reaching movement and so conditioning has taken place. If this reaching movement provides the conditioned response relating to the meaning of the word, then generalisation has taken place because reaching movements might be made to different dissimilar objects. Finally when differing motor movements have to be made to reach for different objects, discrimination may be said to have taken place. This explains how passive language habits (that is the response to words) get conditioned.

There is also the use of words to consider and this is akin to instrumental conditioning. The child has a fairly wide range of babblings in his repertoire and he incessantly repeats these. Let's take the word "ma". The child sees its mother and at the same time makes many noises like ga, da, ma, and so on. When only one of these responses (namely, ma) receives reinforcement in the shape of a hug or smile from the mother, this particular response is conditioned to the stimulus. This might be the way that active language habits originate. Though Watson probably thought on these lines, I doubt whether he would have agreed to the idea of reinforcement strengthening a response. He contended that out of trial and error behaviour, even active language habits developed.

Though Watson inaugurated the behaviourist school, subsequent psychologists who professed behaviourism, placed so many varied and differing interpretations on what the word meant that, at the present time, there are as many different kinds of behaviourists as there are schools of psychology.

Karl L. Lashley believed that introspection had a very important place in objective study of psychology. He was also a physiologist who, by progressive ablation of the brain of an animal, sought to discover the truth of cortical localization. He finally came to the conclusion that the brain showed mass action and equipotentiality—that is the degree of disruption of mental function depended only on the amount of brain injury sustained and not on its location. Walter S. Hunter, another behaviourist, is responsible for experiments on "delayed reaction" and the "temporal maze".

E. C. Tolman incorporated into his behaviourism the doctrine that animals also showed "purposive behaviour" as did human beings. For instance, a rat once fed in the food box in a maze, orients its movements at every subsequent trial towards the goal (food box) and takes shorter and shorter routes till at last it travels only the shortest distance during the final trials. To answer the obvious objections of die-hard behaviourists that to credit an animal with purpose and knowing would be to say that it is endowed with consciousness, Tolman replied that while he would not like to comment on what went on inside the rat, it was obvious to everyone that the taking of the shortest route in the maze by the rat showed that the rat was going towards the food box.

Watson had not explained the relation between the internal physiological changes which go with the observed behaviour. According to Tolman, behaviour, when explained in terms of physical and physiological details, constituted the "molecular" definition as opposed to the "molar" according to which behaviour taken in its entirety constituted more than merely the sum of the physiological reactions involved. Tolman was also responsible for inventing the concept of the "intervening variable". Before his time experimenters dealt with only two types of variables, the experimental variables consisting of changes in the conditions of the experiment and the behaviour variables, the observed changes in behaviour due to the variations of the conditions of the experiment. Intervening variables are those which occur in the organism between the stimulus and response. Of course the intervening variables have no independent existence apart from the other two variables, and can consist of "demand variables" like sex, hunger, demand for a refuge from danger and demand for a place of shelter, or they can also be "cognitive variables" like perception of objects, skills in motor activity and so on.

Clark L. Hull does not deny the existence of consciousness in an organism but emphasises that this property need not be given priority. If an elaborate physiochemical robot were built, nothing which does not occur in the robot should be assumed in any living organism. He accepted Tolman's concept of the intervening variables and initiated drive as the most important of these. Hull wanted to quantify behaviour elements and presented a mathematico-deductive theory of what happens between stimulus and response. This presentation consisted of a number of formulae progressively linked together. He based his system on Pavlov's "conditioned reflex" theory but differed from Pavlov's concepts in regard to certain important details. To explain the reinforcing property of a reward, Hull rejected Thorndike's idea of a "satisfying state of affairs" and substituted reduction of a need or its cessation. Hull's mathematico-deductive system consists of a number of postulates most of which are in close agreement with experimental results.

B. F. Skinner was an exponent of the "molar" concept in that he was all for observing the overt behaviour of the organism without bothering about its physiological substrate. As explained elsewhere, Skinner initiated the expression "instrumental conditioning" (or operant conditioning) as against the Pavlovian "respondent conditioning".

It will be clear from the foregoing account that 'behaviourism" is a

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progressively evolving school of thought. The adherents to the principle of behaviourism do not hold identical views and there is an active trend towards quantification of behaviour elements.

GESTALT PSYCHOLOGY

The founding of this school of psychology came about in this fashion. Max Wertheimer and his colleagues, Kurt Koffka and Wolfang Köhler, were experimenting on the perception of apparent movement—later to be named the phi phenomenon. When two vertical lines of light were presented side by side and one after the other, certain peculiar effects were seen, depending on the time interval between the two presentations. If the interval was more than a fifth of a second, each line was separately seen one after the other. If the interval was reduced to 1/30th of a second, there was no perception of succession but both lines were seen together side by side. Between these two extremes—at 1/15th of a second, for instance—the line appeared to move from one position to the other. Wertheimer tried this phenomenon using arrows pointing in opposite directions and also when the lines were making an angle of 90 degrees between them. In every case there was an optimum time interval at which a clear swing appeared to take place from one position to the other.

The hypothesis that the perception of apparent movement was due to the movement of the eyes from one position to the other, was disproved because in the experiment using two arrows of light pointing in opposite directions, the eyes cannot obviously move in opposite directions at the same time. Another hypothesis put forward to explain this observed apparent movement holds that we actually see one line fixed at a particular position and the other, a little later, in the next position and thereby infer movement. But actually we do not first get a sensation of separate positions and then get a perception of movement. The perception of movement is the only sensation we are aware of. Not only that, in the light of these hypotheses, it is hard to explain how and why apparent movement stops when the time interval between presentations, is altered. Wertheimer postulated that processes in the brain corrsponding to the external stimulus, actually merged from one position to the other and therefore actual movement was present in the brain.

While the phi phenomenon itself was not adequate grounds to initiate a new school of psychology, it nevertheless set them thinking as to the dynamics of perception. They realised that perception of any situation was not built up of the perception of constituent parts of it but that the percept had original properties of its own. Especially in the case of shapes it was observed that the whole shape often displayed characteristics not present in the parts. The word "gestalt" means shape in German and thus the school of gestalt psychology was born in the year 1912.

Christian von Ehrenfels explains this gestalt or form quality by illustrating his point with an example from the world of music. A tune is made up of several notes; but each note by itself does not evince the quality of the particular tune. This is seen by the fact that if all the notes occurring in a tune are rearranged in a different way, the resulting tune also will become different. It is the relationship of all the notes to one another that gives rise to the tune. This point becomes clearer when we realise the fact that even when all the notes are changed it is possible to retain the character of the tune under certain circumstances. This happens when a melody is transposed into another key, whereupon the tune is retained and can easily be recognised although the notes may be changed. This phenomenon in which the context and position of the individual constituents determine the form quality of the whole while these constituents themselves do not possess any unique characteristics which could add up to give the observed gestalt, is known as the law of membership character. In a simple experiment to demonstrate this principle, a red cross is shown against a grey background. To a person who looks at this cross for about half-a-minute, a green border appears round the cross. If, however, a tiny piece is notched off from anywhere on the cross, it might be expected that the cross, at this particular point, would appear green. If this expectation is fulfilled, the total form quality of the cross would have been destroyed. But in actual practice, the notch appears red thus retaining the total form quality of the cross. This experiment would make it appear that the gestalt determines how the constituents would look and not vice versa.

The principle of "Prägnanz" is another fundamental concept in Gestalt psychology. Whenever any given structure is unstable or asymmetrical there is a tendency for the perceptive apparatus to apprehend it in a more symmetrical and "better" form. In the field of memory this has been demonstrated by various experimenters. In such a typical experiment, abstract geometrical figures would be presented and the retention tested after various specified intervals. Under such circumstances, many experimenters claim to have observed progressive changes towards "goodness" (prägnanz). Allport tested the retention of asymmetric figures by 350 school children and found a progressive trend towards greater symmetry but none in the opposite direction, *viz.*, from symmetry to asymmetry. In experiments with meaningful verbal material, Bartlett found that memorial retention over increasing intervals always showed progressive elimination of incongruent, unintelligible details, while the story used in these experiments underwent a modification more in conformity with the memoriser's norms. This phenomenon which he termed conventionalization, is just another aspect of the principle of prägnanz.

Among the other principles of organization may be mentioned the factors of nearness, similarity and closure, all of which can best be illustrated by the following diagrams.

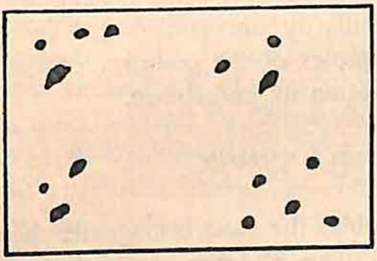

FIG. 19

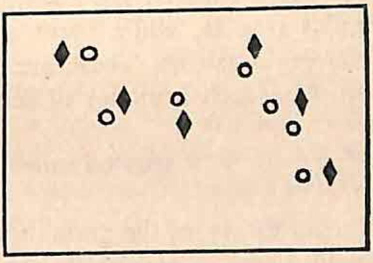

FIG. 20

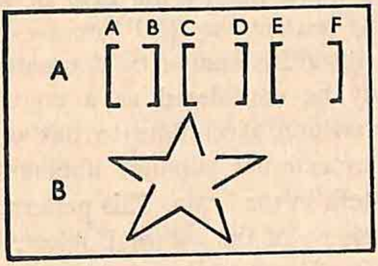

FIG. 21

In Fig. 19, we tend to see the fifteen dots as four groups because the dots in each group are near one another but the distance of each group from the others is more than that among the dots in each group. The principle of similarity is illustrated in Fig. 20, in which the tendency is to perceive all diamond-shaped figures together and the circles as a separate group although the circles are closer to the diamond-figures. In Fig. 21 *A*, the lines *B* and *C* are very close together but *A* and *B* are seen as a separate group while *C* and *D* are seen as another group. This would illustrate the principle of closure. The short arms drawn inwards from these lines have a tendency to "close" the gap. We see an accentuation of this principle in Fig. 21 *B*, in which we tend to see the star as a complete figure even though sections of it are missing. In the memorial retention of abstract figures over progressively increasing periods of time, several experimenters claim to have demonstrated the principle of closure.

All these instances make it clear that there are various organising factors at work in any kind of perception; some of these factors like similarity, proximity, good continuity and closure, are inherent in the stimulus objects, while "set" and familiarity are contributed by the perceiving organism. These are just samples of the complex processes at work in such a matter of fact operation as perception.

ISOMORPHISM AND FIELD THEORY

The field theory of the gestaltists resembles the electro-magnetic theory of field forces in physics. In the latter, lines of force are envisaged as surrounding a conductor of electricity and also operating between the poles of a magnet. But the field forces in physics can be demonstrated and their direction mapped out by the help of iron filings or with a magnetic compass. At present the field forces existing in the brain as conceived of by the gestaltists cannot be demonstrated in this way. At the most it can only be considered as a convenient abstraction to explain observed behaviour. According to this concept the nerve impulses initiated by an external stimulus impinging on the perceiving organism, form a pattern in the brain. This pattern, though not a photographic copy of the shape of the external object, is nevertheless a fair representation of it. For instance, if a circle is the shape perceived, the pattern of electrical impulses flowing in the brain would resemble a closed circular figure. However, the matter does not end with the electrical representation of the pattern in the brain. Waves flow outwards from the boundary of the pattern and create an area of polarisation; the effect of this would be to resist the flow of any further current in the same area. This field concept was also used to explain why "figural after-effects" take place.

In a nut-shell, the principle of isomorphism can be defined as the concept which envisages the formation of an electrical pattern in the brain resembling the external stimulus which produced it. While no point-to-point or true-to-scale representation is contemplated by this description, the gestalt psychologists only believe that each stimulus object perceived produces its own characteristic pattern of field forces in the brain.

Insight: Many psychologists were not satisfied with Thorndike's exposition of the "trial-and-error" theory of learning especially when applied to the cat in the puzzle-box problem. Among the foremost of such critics, Köhler realized that when the problem involves actions not usual in the repertoire of an animal and when all the aspects of the problem are not clear to it, there can only be a blind approach. In an ideal arrangement, all aspects of the problem would be clear to the animal and then "insight" would operate in preference to trial-and-error. By insight Köhler meant the sudden awareness of the implications of a problem and its consequent facile solution. Not much of tedious and gradual elimination of mistakes should be involved in an insightful solution. In his book, *The Mentality of Apes,* Köhler describes many experiments on chimpanzees to illustrate his point. In one such experiment a bunch of bananas was hung on the roof of a shed out of reach of a chimpanzee. But a box was left lying in a corner. Most of the chimpanzees quickly solved the problem by dragging the box to the middle of the shed and reaching for the bunch of bananas by climbing the box. However, when a number of boxes had to be piled on top of one another to get the required height, even Sultan, the brightest of the chimps, failed.

The jointed stick problem produced a period of indifferent activity to be followed by a sudden solution when the chimpanzee accidentally joined the two short sticks together to make one stick long enough to draw in a piece of fruit lying outside the cage. Köhler decided that the chimpanzee was "aware" that if it could have a stick long enough to reach the fruit, the problem could be solved. When it found that the sticks could be joined together in this way the problem became simple. According to Köhler, insight is proved by three factors, *viz.,* the appearance of a sudden solution to a problem, good retention over long periods of time and the ability to carry it over to other situations.

Wertheimer investigated the teaching of mathematics in schools and found that most teachers were getting their students to memorize mathematical formulae without acually helping them to realize what exactly was involved. He demonstrated how the child could be led to discover the principle involved if the problem was presented in the proper way. According to Wertheimer, trial-and-error methods should never form part of the learning procedure but it should always involve insight.

Kurt Lewin, an enthusiastic exponent of gestalt psychology, evolved new methods of presenting psychological situations along the lines usual in that branch of mathematics known as topology which deals with the boundaries of regions, their subdivisions and the modes of progression within these areas. Lewin describes a life space within which psychological motion towards goals take place. He represented various problems of life in the form of diagrams showing barriers confining the life space of the individual and his reactions to such restrictions. For instance, some people instead of tackling the real problems of life "leave the field" or escape into the world of phantasy. Lewin also evolved a number of mathematical expressions to prove his point. His diagrams and formulae represent a new approach to the portrayal of psychological problems.

His work in the field of social psychology is varied and interesting. Acting on the assumption that frustration would produce regression, he experimented with young children of pre-school age. To begin with, the children were given a set of conventional toys and their behaviour with special reference to social constructiveness was carefully noted. Then some new and fascinating toys were introduced whereupon the delighted children indulged in very mature ways of handling the toys. Soon after, the toys were removed and placed behind a grill through which the children could see them but not get at them. The sorely disappointed children returned to their old toys but regressed to a very undifferentiated level of play. For example, the child which had delighted in carrying on an animated conversation with a friend over the toy telephone, now merely banged it as a rattle.

Another experiment which Lewin carried out along with Lippit and White, studied the behaviour of children when they were subjected to authoritarian, *laissez-faire*, and democratic leaderships respectively. The results of these investigations showed clearly that democratic leadership make for a contented, happy group in which cooperation and cheerfulness were at a maximum level. Lewin's contributions to gestalt psychology in particular and also to the study of psychology in general are sufficiently important to warrant the inauguration of a school of thought as separate from the other gestaltists.

In conclusion, it must be granted that while many aspects of gestalt psychology remain obscure and unexplained, there is no denying the fact that the main bases on which this school of thought is founded represent a very dynamic approach to the problems of psychology.

STRUCTURALISM versus FUNCTIONALISM

Wilhelm Wundt (1832-1920) established the first psychological laboratory in Leipzig in the year 1879. One of the earliest tasks he set himself was to try to discover the elements present in conscious experience which, he thought, fell into two main categories; there are the sensations which seem to come to us from outside as a result of our commerce with the environment, and secondly there are the feelings which form part of our "internal experience." The sensations which we experience have already been classified by physiologists into colours, tones, tastes and skin sensations respectively depending on the sense modality referred to. Wundt proposed a tri-dimensional analysis of feeling, the pleasant and unpleasant, the excited and quiescent, the tense and the relaxed. Quantitative and qualitative blends of these elements would create all the feeling tones which we experience. In addition Wundt also formulated the theory that the "Psychic compound" which is formed by the combination of these elements, possesses many new properties which are not merely a sum of the characteristics of the elements. This is reminiscent of the properties of a chemical compound that differentiate it from the elements which are its constituents.

The school of thought, originally founded by Wundt which recognised conscious experience as the starting point and explored by analysis and synthesis the elementary structure of experience, came to be known as Structural Psychology. Edward Titchner (1867-1927) the foremost pupil of Wundt preferred to refer to the adherents of this school of thought as existentialists rather than as structuralists. He and his pupils tackled many such problems as the role and nature of attention, and the modes of composition of the elements which constitute our feelings. Titchner's psychological laboratory at Cornell University initiated systematic studies of sensations from skin and viscera and also considered whether "opposing" elements like pleasantness and unpleasantness could exist side by side in consciousness at the same time. Introspection as a rigorous method of psychological experimentation flourished under the aegis of the Structuralist school. To minimise the individual differences among subjects, a very strict training was prescribed for introspectionists, and in addition to this many refinements in experimental techniques were developed to correct for the inadequacy of verbal reports.

But structural psychology had to encounter a great deal of criticism because a mere study of the elements of experience does not seem to convey the dynamism which should really belong to the study of the mind. So a shift in emphasis gradually took place from "stages" to "processes". Thus was born the Functionalist School of Psychology championed by John Dewey the famous philosopher and J. R. Angell, an able man in the field of educational administration. The adherents of Functionalism felt that to analyse the structure of sensation or feeling divorced from the organism which experiences it would only be an incomplete approach to a problem which is much more dynamic. In this they were influenced by William James who wrote that consciousness is not a by-product of somatic causality but is rather a causal agent itself in the life of the organism. In the early days of Functionalism however, psychology was still held to be the science of consciousness and therefore dealt primarily with the problems of what need of the organism are served by sense perception, memory images and emotion. A phylogenetic study by the functionalist school of psychology aimed at the estimation of the respective stages in evolution at which various mental processes may have developed. A direct result of this orientation in psychological thought was the increase in the volume of animal experimentation and the consequent establishment of animal laboratories under the influence of the functionalists. The advent of Harvey Carr into the ranks of the American functionalists elminated even the last vestiges of introspection from psychological research techniques.

The European functionalists were perhaps a little more strongly oriented in favour of the genetic approach from the very beginning. One of the best known among them, Edouard Claparède (1873-1940) founded the J. J. Rousseau Institute for the developmental study of children; he was opposed to the traditional teaching methods of the time and introduced revolutionary ideas into education. He believed in introspective techniques but evolved his own methods of observing mental processes. He was an open-minded experimentalist who actively advocated an eclectic approach towards psychological problems.

Some psychologists like David Katz and Edgar Rubin were influenced by the Phenomenological approach which deals with the study of the appearances of objects and phenomena. The studies by Katz of the appearance of colours and of colour constancy have been important contributions and have helped in the furtherance of research in visual perception. Likewise Rubin's work on the figure and ground characteristics of objects in our environment has increased our knowledge of the perceptual mechanism. The Phenomenological method also can be included in the Functionalist School of Psychology as it conforms to the general functionalist approach of starting with the results obtained and of proceeding to find out how they have been accomplished.

CHAPTER ELEVEN

Statistics

THE role of statistics in psychology is a vital one because the results of experimentation are usually expressed in quantitative terms. Not only do statistical methods help the investigator to draw valid conclusions but they also determine as to when conclusions should not be drawn from a set of results. It is not intended here to make an attempt to deal with the theoretical bases of statistical methods. However, the procedure adopted in statistical tests will be outlined together with examples so that the student will have a ready reference at hand to aid him in his calculations.

GRAPHIC METHODS

(A) *The Line Graph*: This kind of graph is also known as the frequency polygon and is the most widely used. The horizontal line is called the *X* axis and the vertical the *Y* axis. Fig. 22 shows the results of a mirror drawing experiment. In the graph the number of trials are shown along the *X* axis and the number of errors made in each trial along the *Y* axis.

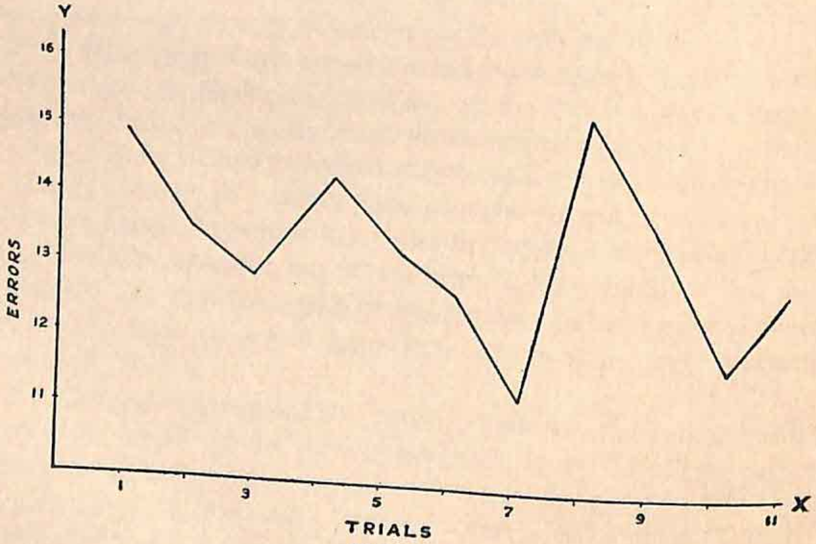

FIG. 22

Fig. 23 shows the famous "curve of retention" produced by Ebbinghaus. In this experiment, nonsense syllables were learned and retention measured after various intervals of time—1 hour, 9 hours, 24 hours, 48 hours and 6 days (144 hours) respectively. The *X* axis shows the different time intervals and the *Y* axis the percentages of the original material retained.

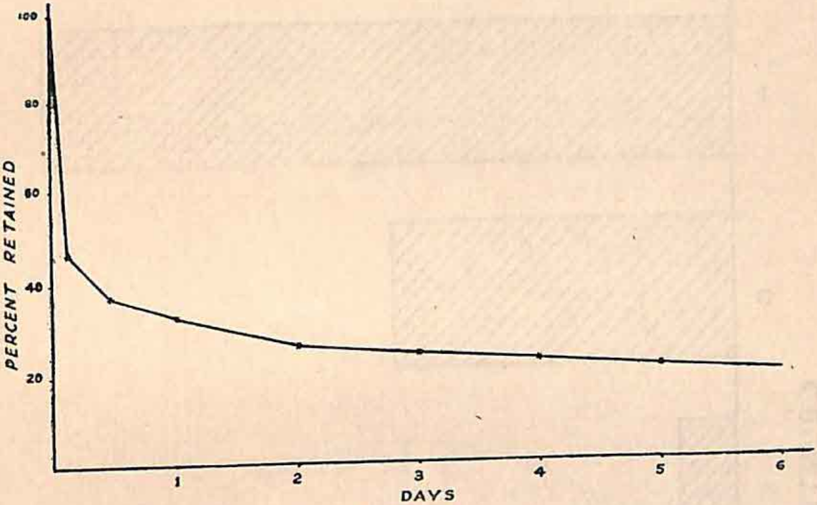

FIG. 23

(B) *The Bar Graph*: When many groups are to be compared in regard to a particular characteristic, the bar graph is generally used. For example, the bar graph can be drawn to compare the amount of money spent by various countries on armaments. Or, it can represent the number of deaths per thousand of the population due to tuberculosis in different countries of the world. If we wish to see at a glance the relative proportions of affective reaction types, schizophrenics, paranoics and organic reaction types among the patients in mental institutions, a bar graph would serve the purpose well.

Example: The value of exports of cotton from five countries, *A*, *B*, *C*, *D*, and *E*, are as follow: (Fig. 24).

A	£ 18,000,000	*D*	£ 750,000
B	£ 9,000,000	*E*	£ 250,000
C	£ 1,750,000		

This is an ideal situation for a bar graph which will show at a glance the relative values of the exports.

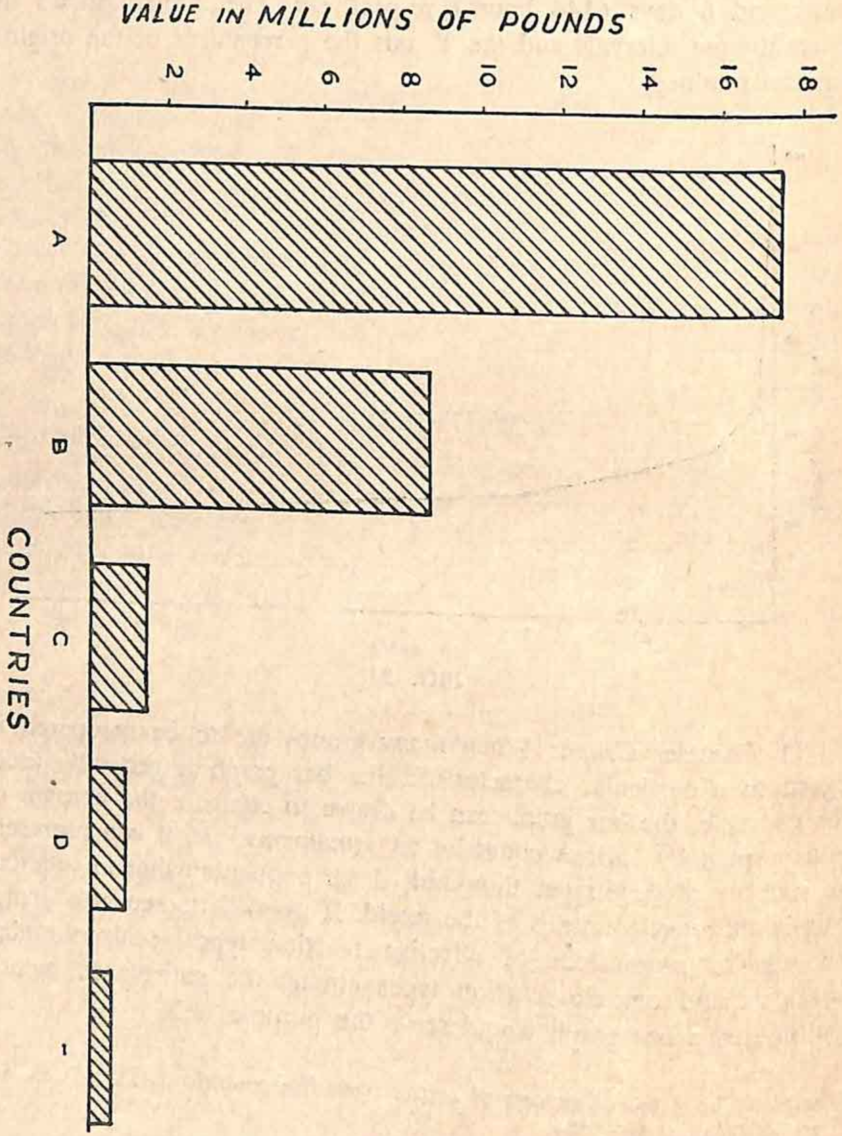

FIG. 24

(C) *The Circle Graph or Pie Diagram*: As the name indicates, this diagram is in the shape of a circle.

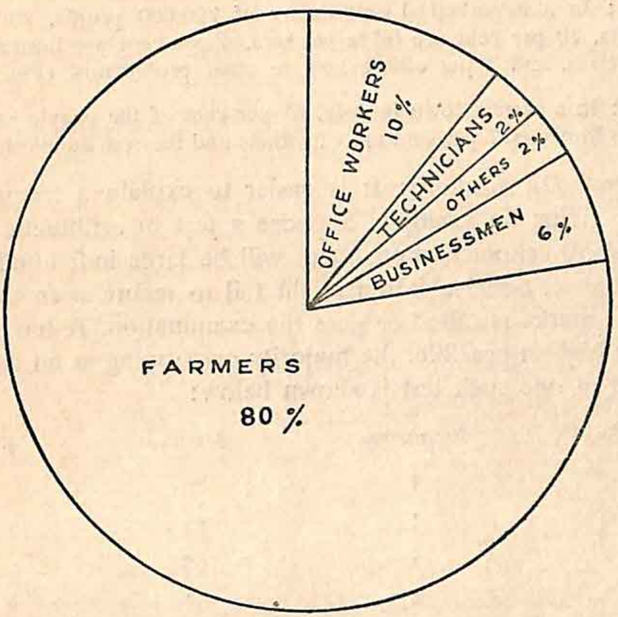
OFFICE WORKERS 10%
TECHNICIANS 2%
OTHERS 2%
BUSINESSMEN 6%
FARMERS 80%

FIG. 25

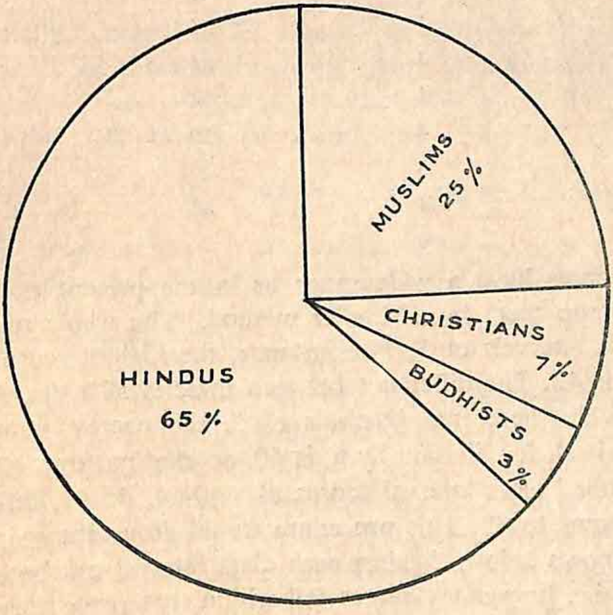
MUSLIMS 25%
CHRISTIANS 7%
BUDHISTS 3%
HINDUS 65%

FIG. 26

Example 1: In a hypothetical community of 200,000 people, 80 per cent are agriculturists, 10 per cent are office workers, 6 per cent are businessmen, 2 per cent technicians, and 2 per cent belong to other professions. (Fig. 25).

Example 2: In a certain town in Asia, 65 per cent of the people are Hindus, 25 per cent are Muslims, 7 per cent are Christians and the rest Buddhists. (Fig 26).

Frequency Distributions: It is easier to explain a frequency distribution by giving an example. Suppose a test in arithmetic is given to a group of 50 schoolchildren; there will be large individual differences in performance. Some children might fail to secure even the minimum number of marks required to pass the examination. A few might score nearly the highest possible, the majority performing at an average level. The result of one such test is shown below:

Marks	*Frequency*	*Marks*	*Frequency*
99	1	70	4
93	1	67	2
92	1	65	4
89	2	63	1
87	1	62	1
85	1	60	2
84	1	56	3
82	3	55	1
81	1	54	1
78	4	50	1
76	3	49	3
75	1	42	1
74	6		

Where scores have a wide range as in the present example, it is easier to group them by a simpler method. The whole range can be divided into intervals of 5. For instance, the highest score is 99 and the lowest is 42. The difference between these is 57 units. As we propose to divide these into intervals of 5, the nearest number which would lend itself for division by 5, is 60. So starting from 40, we make what are called class interval scores like 40-44, 45-49, 50-54 and so on till we come to 99. This procedure would group the scores into 12 classes as shown below. Against each class interval can be entered the frequency—i.e. how many scores fall within that range. Arranging the marks of the 50 students according to this plan we get:

Class-interval score	Midpoint (X)	f-(Frequency)	fX
95-99	97	1	97
90-94	92	2	184
85-89	87	4	348
80-84	82	5	410
75-79	77	8	616
70-74	72	10	720
65-69	67	6	402
60-64	62	4	248
55-59	57	4	228
50-54	52	2	104
45-49	47	3	141
40-44	42	1	42
		N = 50	3540

The figures in the column showing the midpoint is arrived at by finding the mean of the highest and the lowest score of each class interval and denotes the middle point score in that interval. For example, in the class interval 95-99, the midpoint will be $= \dfrac{95 + 99}{2} = 97$. The midpoint is usually denoted by X. When each midpoint is multiplied by its frequency we get the total of all the scores in that class interval. This is column fX. There are three quantities, the mean, the median and the mode which are usually calculated.

(1) *The Mean*: $M = \dfrac{\Sigma fX}{N}$ where $\Sigma\ fX$ means the sum of all the totals in the column fX (Σ means sum of), and N is the total number of scores or the total frequency given under f. In this instance the mean $= \dfrac{3540}{50} = 70.80$

(2) *The Median* is the middle point; it is the score of the 25*th* person because this is the middle point of 50. The procedure to calculate the median is as follows:

Start at the lower end of the score range. Add up the frequencies in order from the lower end. From the score range 40-45 to 65-69 (inclusive) there are 20 cases. The next frequency is 10. So obviously the 25th frequency lies in the next interval 70-74. The beginning of this interval is 69.5 and it is the score relating to the 20th frequency.

Add to this the proportionate score of the 5 frequencies in the next interval. This is found out as follows: We want only 5 out of the 10 frequencies. So the fraction is 5/10. The class interval is 5 units, and 5/10th of $5 = 2.5$. The median $= 69.5 + 2.5 = 72.0$.

(3) *The Mode*: The mode, as the name implies, is the most fashionable score, that is the one which occurs most frequently. Looking at the figures given above, we can find out very easily that 10 persons have a score of 72. As this is the most popular score, we say that 72 is the mode. This way of calculating gives us only the "crude" mode. A more accurate way of calculation is by the use of the formula, mode = 3 medians—2 mean. In the present example the mode = $(3 \times 72) - (2 \times 70.8) = 74.4$.

Percentile Scores: A percentile score is one below which a certain percentage of the scores lie. For instance P_{10} denotes the percentile score below which lie 10 per cent of the scores. The calculation is exactly like that used for finding the median. Let us use the same example for calculation of the Percentile scores.

P_{10}: There are 50 frequencies. As 10 per cent of 50 is 5, we want the fifth score starting from the lowest class interval. This lies in the third class interval starting from below. The beginning of this interval is 49.5. Therefore $P_{10} = 49.5 + (\frac{1}{2} \times 5) = 52.00$. P_{30} is the 15th score and is equal to $64.5 + (1/6 \times 5) = 65.3$. P_{40} is the 20th score and is equal to $69.5 + (0/10 \times 5) = 69.5$. Similar calculations will show that $P_{60} = 74.5$ and $P_{80} = 81.5$.

P_{25} is known as the first "quartile" and P_{75} the third quartile usually represented by Q_1 and Q_3 respectively. The quartile (Q) is the mean of Q_1 and Q_3.

The Standard Deviation (*S.D.*): The mean does not give us any information about the range of the scores or the way in which they are distributed. Let us take a hypothetical case. Look at the 3 sets of results A, B & C below:

	A	*B*	*C*
	42	20	54
	45	50	61
	69	70	62
	73	80	63
	81	90	70
Total =	310	310	310

$$\text{Mean} = \frac{310}{5} = 62.0$$

In every case the mean is 62. But in *A*, the lowest score is 42 and the highest 81 showing a great variability. In *B* there is extreme variability and it will be observed that the lowest score is 21 and the highest 90. In *C* the scores are close together, the lowest being 54 and the highest 70.

Yet in the three cases the mean is the same. It is clear that the mean cannot therefore be a true measure of the variability of the scores. To have an idea as to how much the scores are scattered on either side of the mean, we compute a measure known as the standard deviation (S.D.). This is how the standard deviation can be calculated. First of all, the mean is found and is subtracted from individual scores; When the mean is greater than a score, the result will bear a negative sign (—) in front of it. The results of this subtraction of the mean from the individual scores—known as the deviations from the mean—are then squared individually and the sum of the squares found out. Using the formula, S.D. $= \sqrt{\frac{\Sigma x^2}{N}}$ (where Σx^2 is the sum of squares of the deviations and $N =$ the number of scores), the standard deviation is calculated. Let us take Table C in the example given above and calculate the S.D.

Scores	*Deviation* (x)	x^2
54	—8	64
61	—1	1
62	0	0
63	1	1
70	8	64
310		130

Mean = 62 $N = 5$

$$\text{S.D. (Standard Deviation)} = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{\frac{130}{5}} = 5.099.$$

Short Method: It sometimes happens that the mean is not a whole number and in that case the squaring of the deviations produces unwieldy numbers. Therefore a short-cut is used. These are the steps.

(1) Choose a convenient assumed mean. This can be done by inspection of the scores.

(2) Subtract this mean from each item thus finding the deviations. Place the correct signs in front of each deviation, and find the sum of the deviations.

(3) Square each deviation and find the sum of the squares.

(4) *Correction factors*: There are two corrections to be calculated when using an assumed mean.

(*a*) *Correction to find the real mean*: Divide the sum of squares by the total number of scores, taking care to keep the correct sign. If the answer is negative, subtract it from the assumed mean. If it it positive, add it on to the assumed mean, to arrive at the true mean.

(*b*) *Correction to be applied to the Sum of Squares of the deviations*: Square the sum of deviations and divide by the total number of scores. The result is always subtracted from the sum of squares of the deviation to arrive at the true sum of squares of the deviation. From this the standard deviation is calculated in the usual way.

Example 1

Scores	*Deviation from the mean*	*Squares of deviations from the mean*
54	—6	36
61	1	1
62	2	4
63	3	9
70	10	100
	Total = 10	150

In the above example, the assumed mean is 60.

a. The correction factor for the mean $= \frac{10}{5} = 2$

Real Mean $= 60 + 2 = 62$.

b. The correction for the sum of squares of the deviations from the mean $= \frac{(10)^2}{5} = 20$. The true sum of squares

$= 150 — 20 = 130$ S.D. $= \sqrt{\frac{130}{5}} = 5.099$

Example 2

SHORT METHOD

Score	*Deviations*	x^2
87	17	289
86	16	256
92	22	484
76	6	36
58	—12	144
89	19	361
94	24	576
66	— 4	16
72	2	4
78	8	64
80	10	100
84	14	196
962	122	2526

Assumed mean $= 70$

Correction for mean $= \frac{122}{12} = 10.17$

Correct mean $= 70 + 10.17$
$= 80.17$

Correction for sum of squares of deviation from the mean $= \frac{(122)^2}{12}$

$= 1240.33$

The Corrected sum of squares $=$
$2526 — 1240.33 = 1285.67$

$$\text{S.D.} = \sqrt{\frac{1285.67}{12}} = 10.35$$

LONG METHOD

Score	*Deviations*	x^2
87	6.83	46.65
86	5.83	33.99
92	11.83	139.90
76	4.17	17.39
58	22.17	491.50
89	8.83	77.97
94	13.83	191.20
66	14.17	200.80
72	8.17	66.75
78	2.17	4.71
80	0.17	0.03
84	3.83	14.67
962		1285.56

Correct mean $= \frac{962}{12} = 80.17$

Sum of squares of deviation from the mean $= 1285.56$

$$\text{S.D.} = \sqrt{\frac{1285.56}{12}} = 10.35$$

Usually in psychological experiments only a sample of the total population is tested. The S.D. of this sample most often underestimates the S.D. of the corresponding population, this effect being particularly accentuated when the sample is very small. A slight modification to the original formula for the calculation of the S.D., has been found to give more accurate results and that is:

$\text{S.D.} = \sqrt{\frac{\Sigma x^2}{N\text{-}1}}$ where the quantity N-1 is usually referred to as the Degree of Freedom.

Variance: The variance is obtained by dividing the sum of the squares of the deviation from the mean, by the degree of freedom, and is also a measure of the scatter of the scores.

$$\text{Variance} = \frac{\Sigma x^2}{N} \text{ or } \frac{\Sigma x^2}{N\text{-}1}$$

It will be seen from this formula that variance is the square of the S.D.

$$\text{V} = (\text{S.D.})^2$$

[Note: standard deviation is usually denoted by σ (sigma)]

Standard Error: When the sample is large, the reliability of the mean and therefore of the S.D. increases. If the sample is small, the reliability of the Mean and the S.D. decreases. The standard error provides a measure as to the margin of error to be expected in the mean.

$$\text{Standard Error, S.E.} = \frac{S.D.}{\sqrt{N}} = \frac{\sigma}{\sqrt{N}}$$

It can easily be seen from this formula that as the number representing the degree of freedom increases, the value of S.E. decreases. This can be made clear by working out an example. Suppose the S.D. is 8.4 and the number of samples involved is 10, the S.E. $= \frac{8.4}{\sqrt{10}} = 2.65$.

If the number in the sample had been 100, S.E. $= \frac{8.4}{\sqrt{100}} = .84$

If the number is increased to 144, the S.E. becomes 0.70.

The Normal Distribution: In any population, if the incidence of a particular characteristic is assessed, some people will be found to have too much of it, some very little of it, and the majority will be found to possess average quantities of it. In fact, if the values are plotted on a graph, a bell shaped curve showing perfect bilateral symmetry will be obtained. Such a distribution is known as the normal distribution. While this is a theoretical possibility, 100 per cent normality of distribution is somewhat rare, but a fair conformity is the rule rather than the exception. Intelligence scores, various physical characteristics and personality traits all show fair normal distributions. Whenever a psychological test is given, the results obtained are assessed in terms of what they should have been had there been a complete conformity to the normal distribution.

The Principles of Probability: If a coin is tossed, there is the equal likelihood of its landing with either the heads up or the tails up. The probability of the coin showing heads is 1 in 2 and the probability of its showing tails is also 1 in 2. Probability therefore means the expected frequency of an occurrence among similar events and is usually expressed as a mathematical ratio.

If a dice is cast, there is the equal likelihood of the face showing 1, 2, 3, 4, 5 or 6. So the probability of a particular number appearing on the top face is 1/6. Therefore, the probability of any number appearing is $1/6 + 1/6 + 1/6 + 1/6 + 1/6 + 1/6 = 1$.

If we toss 2 coins, the probability of heads and tails appearing can be represented by the expression $(H + T)^2$ where $H =$ heads and $T =$ tails. On expansion of the binomial we get $H^2 + 2HT + T^2$. This formula also makes it clear that the total number of ways in which the heads and tails can combine to give different results, is 4.

1 H^2—1 chance in 4 of both coins showing heads.
2 HT—2 chances in 4 of 1 heads and 1 tails
1 T^2—1 chance in 4 of both coins showing tails.

If three coins are thrown, the binominal becomes $(\mathrm{H} + \mathrm{T})^3 = H^3 + 3H^2T + 3HT^2 + T^3$.

1 H^3—1 chance in 8 of 3 heads.
3 H^2T—3 chances in 8 of 2 heads and 1 tails.
3 HT^2—3 chances in 8 of 1 heads and 2 tails.
1 T^3—1 chance in 8 of 3 tails.

The binomial for 4 coins will be $(H + T)^4$.

Thus the probability of any particular combination of heads and tails turning up can be easily found out by expanding the appropriate binomial. The immense labour involved in expanding the binomial can be simplified by using Pascal's triangle shown below:

1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1

The numbers in this triangle represent those which have to be placed in front of each item in the expanded binomial expression. Thus the apex of the triangle represents the condition of $H + T$ (i.e. 1 of each item). The line below that shows 1—2—1. This is the condition applicable for $((H + T)^2$ (in which the expanded expression shows $\underline{1}\,H^2 + \underline{2}HT + \underline{1}\,T^2$: the underlined numbers are those which occur in the second line from the top of the triangle).

The third line, 1-3-3-1 shows the numbers which should be placed in front of each item of the expanded form of the binomial $(H + T)^3$. $(\underline{1}\,H^3 + \underline{3}\,H^2T + \underline{3}\,HT^2 + \underline{1}\,T^3)$.

Characteristics of a Normal Curve: The normal curve is also known as the probability curve. In such a curve, if a perpendicular is drawn from the point representing the mean, it will divide the curve into two bilaterally symmetrical parts. From the mean, distances representing 1 σ, (standard deviation,) 2 σ, and 3 σ could be marked off on either side on the 'X' axis. Distances marked on the right hand side of the mean would be + and those on the left—. It will be seen that 68.26 per cent of the total number of cases lie between + 1 σ and —1 σ. 95.44 per cent of the cases lie between + 2 σ and —2 σ. 99.73 per cent of all frequencies lie between + 3 σ and —3 σ. Tables have been prepared which show at a glance the number of cases that lie between any given value of the S.D. and the Mean.

Differences between Experimental curves and Normal curves: (1) *Skewness*: In a normal curve, the Mean, the Mode and the Median all coincide and the left half of the curve will be identical to the right half. But experimental curves may not always show this symmetry. When the mean and median do not coincide (that is when the crest of the curve is not in the middle) the curve is said to be skewed. The skewness may be to the left or to the right. When the mean is to the left of the median, the curve is said to show *negative skewness*. In this case scores are massed at the right end of the scale and more gradually spread out at the left end. This makes the right side of the curve show a sudden fall whereas the left side has a gradual incline. *In the case of positive skewness*, the mean is to the right of the median. That means that the scores are massed at the left end of the scale and more gradually distributed on the right. The sudden incline is on the left side and the gradual one on the right.

(2) *Bimodal curves*: Sometimes a curve shows two humps and this can denote some error in sampling, probably because the samples

were not chosen at random. There might have been two different distributions. However it is not possible to draw any such conclusion if the sample is very small.

(3) *Kurtosis*: Kurtosis refers to the sharpness or flatness of the peak of the curve. A curve which is quite pointed at the crest, is said to be *leptokurtic* and one which is flatter at the top than a normal curve, *platykurtic*. The normal curve is *mesokurtic*.

ANALYSIS OF VARIANCE

Simple analysis: Variance $V = \sigma^2 = \frac{\textit{sum of squares of deviations from } M}{\text{Degree of freedom}}$

Analysis of variance is a method by which the variances of groups of scores can be compared and valid conclusions drawn therefrom. An example will make the working clear.

Example: Four groups of 5 persons each, were tested for reading speed under 4 different conditions respectively. The results are shown below:

Time in Seconds

Groups:	*I*	*II*	*III*	*IV*
	96	88	81	72
	102	84	78	74
	94	92	76	70
	98	87	79	68
	92	90	75	67

The scores are too large for easy manipulation and so they can be reduced to smaller dimensions by subtracting 60 from each score. This number is only an arbitrary one—most convenient in this case. The reduced figures are:

Groups:	*I*	*II*	*III*	*IV*
	36	28	21	12
	42	24	18	14
	34	32	16	10
	38	27	19	8
	32	30	15	7

Now the steps to be followed:

(1) Find out the grand total of all scores. Calculate the mean.

(2) Calculate the correction factor by squaring the grand total of

all scores and dividing it by the number of scores. This is the C.F. to be subtracted from all subsequent values (C.F. = Correction Factor).

(3) Square each score and find the sum of these squares (S.O.S.) Subtract the C.F. This gives the Total Sum of Squares.

(4) Then the sum of squares among conditions, is calculated by squaring the sum of each column of the original scores and adding them together. Subtract the C.F.

(5) The Sum of Squares within conditions, is found by subtracting the result of 4 above from that of 3, (i.e. subtract the S.O.S. among conditions from the total S.O.S.).

(6) Tabulate the results. The number of degrees of freedom is calculated as follows:

(*a*) Total degree of freedom = d.f. = N—1, where N is the number of cases.

(*b*) The degree of freedom among conditions is found by using the formula (p—1) where p is the number of conditions.

(*c*) The d.f. within conditions can be found out by subtracting the d.f. among conditions from the total d.f., or it can be found by using the formula p (q—1), where p is the number of conditions (see b above) and q is the number of scores under each condition.

(7) Find the variance by dividing the sum of squares by its d.f. Divide the larger variance by the smaller one. This is called the F. ratio. Refer to the Yates and Fisher Tables to see whether the F-ratio obtained is significant. If the experimental F-ratio is greater than that in the tables, the result is statistically significant at that particular level of probability.

Example: The reduced scores given at the beginning of this section will be used for illustrating the calculation.

	I		II	
	Scores	Squares	Scores	Squares
	36	1296	28	784
	42	1764	24	576
	34	1156	32	1024
	38	1444	27	729
	32	1024	30	900
Total =	182	6684	141	4013
Mean =	36.4		28.2	

	III		IV	
	Scores	Squares	Scores	Squares
	21	441	12	144
	18	324	14	196
	16	256	10	100
	19	361	8	64
	15	225	7	49
Total =	89	1607	51	553
Mean =	17.8		10.2	

The Grand Total of all scores $= 182 + 141 + 89 + 51 = 463$.

General Mean $= \frac{463}{20} = 23.15$

A. *Correction Factor*: $=$ C.F. $= (463)^2 = 10718.45$

B. Total sum of Squares $= 6684 + 4013 + 1607 + 553 = 12857$

$$\begin{array}{rr} \text{Less C.F.} & 10718.45 \\ = & \overline{2138.55} \end{array}$$

C. Sum of Squares among conditions $= \frac{(182)^2 + (141)^2 + (89)^2 + (51)^2}{5}$

$= 12705.00$

Less C.F. $= 10718.45$

1986.55

D. Sum of Squares within conditions $= 2138.55 - 1986.55 = 152$

Tabulated Results:

	d.f.	Sum of squares	Variance $= \frac{\text{S.O.S.}}{\text{d.f.}}$	F.Ratio
Among conditions	3	1986.55	662.2	69.7
Within conditions	16	152.00	9.5	
TOTAL	19	2138.55		

The d.f. for the larger variance (1986.55), is $= 3$
The d.f. for the smaller variance (152) is $= 16$

Now refer to the Fisher and Yates tables. The d.f. for the larger variance is located on the top horizontal row of the tables and that for the smaller variance is located on the first column on the left of the tables. This value is read off. In the present instance it is 9.01 for significance at the .001 level. Our value of 69.7 is many times larger than this figure and is therefore highly significant. After having assessed the actual statistical significance of the results, the next step is to interpret the results. In the example given above, we were trying to find out whether the four conditions are capable of giving widely divergent results consistently, or whether the differences noted are due to individual variations of the subjects. Translating this into statistical language, we can say that we were trying to find out whether there was greater variability *among* the four conditions than *within* the conditions. The greater variance was found among conditions and the F-ratio was found to be significant. So the inference is that there are genuine variations in performances due to the alteration of the conditions.

Two-Way Analysis of Variance: In the example given above, only one variable—the effect of different conditions on the speed of reading—was involved. Sometimes two variables have to be dealt with simultaneously. Then we use the two-way analysis.

Example: Five insurance salesmen were sent to counties A, B and C. Each salesman worked in that county for 4 months. The gross turnover of each salesman (in thousands of pounds) is listed below:

	County A		*County B*		*County C*	
Salesmen	*Turnover*	*Squares*	*Turnover*	*Squares*	*Turnover*	*Squares*
J	12	144	5	25	4	16
P	10	100	6	36	3	9
S	11	121	6	36	5	25
T	10	100	4	16	4	16
L	12	144	5	25	4	16
	55	609	26	138	20	82

Total turnover for each salesman in the four counties	
J	21
P	19
S	22
T	18
L	21
	101

The two variables in this example are the turnover of each salesman and the turnover in each county. How do they interact? Are all salesmen equally good? Is each county equally productive? An inspection of the figures shows that county A has been exceptionally productive, and the other two are far below it in output. The question is, are there genuine differences between the counties, or are these differences due to random fluctuations? All the above questions can be answered by performing a two-way analysis of variance. In this we analyse the variance of both rows and columns.

1. The Correction Factor $= \dfrac{(101)^2}{15} = 680.1$

2. The total Sum of Squares $= (12)^2 + (10)^2 \ \ldots\ldots + (4)^2$

$$= 829.0$$

Less C.F. $= 680.1$

$$148.9$$

3. Among Counties S.O.S. $= \dfrac{(55)^2 + (26)^2 + (20)^2}{5} = 820.2$

Less C.F. $= 680.1$

$$140.1$$

4. Among salesmen S.O.S. $= \dfrac{(21)^2 + (19)^2 + (22)^2 + (18)^2 + (21)^2}{3}$

$$= 683.7$$

Less C.F. $= 680.1$

$$3.6$$

The total of Among Counties S.O.S. and Among Salesmen S.O.S. comes only to 143.7 (i.e., 140.1 + 3.6) whereas the total S.O.S. is 148.9. So there is a residue of 5.2 not accounted for. This is called the Residual S.O.S.

5. The degree of freedom among counties $= (3 - 1) = 2$
The degree of freedom among salesmen $= (5 - 1) = 4$
Total degree of freedom among salesmen $= (15 - 1) = 14$
Residual degree of freedom $= (p-1)(q-1) = 8$

	d.f.	S.O.S.	Variance	F-ratio	P
Among counties	2	140.1	70.00	$\frac{70}{.65} = 107.7$	P > .001
Among salesmen	4	3.6	0.90	$\frac{.90}{.65} = 1.38$	Not sig.
Residual	8	5.2	0.65		
TOTAL	14	148.9			

Among Counties Test of Significance: From the tables we locate d.f. 2 for the larger variance on the top and for d.f. 8 along the vertical. The value given is 18.49 when $P = .001$. In the present example the F-ratio is more than 5 times this number. So the result is highly significant.

Among Salesmen: The d.f. for the larger variance is 4 and the d.f. for the smaller variance is 8. From the tables the figure is 3.84 even for the .05 level of significance. So this result is not significant.

Conclusions: (1) There is a very appreciable difference in the turnover of insurance between counties. Each county varies appreciably in its output.

(2) There is no appreciable difference between the performance of the salesmen. They are all equally persuasive.

CORRELATION

It is a very common phenomenon that when a group of people is tested on the performance in different tasks, the rank of proficiency of an individual in one task does not remain the same in another. Every teacher is aware of this when compiling lists of marks for his class. A boy who stands first in Mathematics may stand at the bottom of his class in some other subject. A boy who is second in his form in English literature may have failed in drawing and so on. This creates a number of difficulties for the teacher. These can be more fully appreciated in the following illustration.

Example: 10 children were tested in English and Mathematics. Their marks are listed below:

Even a casual observation of these results will disclose the following points:

1. The ranks of any particular boy in the two subjects are not the same. For instance the boy (*I*) who obtained first rank in English was 9th in Mathematics. (*D*) was first in Maths but 7th in English.

2. We cannot also say that the boy who came last in one subject has to perform poorly in the other subject also. For instance, (*J*) came last in English but obtained the 5th rank in Mathematics.

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Students:	English	Rank	Mathematics	Rank
A	82	2	56	8
B	78	4	74	6
C	52	8	58	7
D	54	7	94	1
E	74	5	90	3
F	68	6	44	10
G	80	3	87	4
H	50	9	92	2
I	91	1	50	9
J	49	10	78	5

3. It is clear from this that we cannot make a prediction about a boy's placing in one task if we knew only his ranking in another.

All these seem confusing. Some way should be devised so that an effective analysis can be made. This is done by the method of correlation. A quantity *'r'* known as the Coefficient of Correlation helps us to assess the degree of correlation between the two sets of results. Usually three degrees of correlation are employed—positive correlation, negative correlation and zero correlation.

1. *Positive correlation*: When each individual has the same rank in two sets of results, then there is said to be positive correlation. Maximum positive correlation is indicated when $r = +1$. Positive correlation is shown when the coefficient of correlation bears the positive sign.

Example of Maximum positive correlation:

	Marks			
	English	*Rank*	*Maths*	*Rank*
A	90	1	97	1
B	82	3	87	3
C	87	2	92	2
D	51	5	42	5
E	79	4	71	4

2. *Negative Correlation*:

Perfect negative correlation is represented by a value of $r = -1$. This is illustrated in the following example.

	Marks			
	English	*Rank*	*Maths*	*Rank*
A	89	1	43	6
B	82	2	49	5
C	71	3	56	4
D	58	4	78	3
E	54	5	94	2
F	50	6	97	1

3. *Zero Correlation*: Our first example of the ranking of ten students in 2 subjects, shows that there is no uniformity in the ranks. There is absolutely no relationship between a student's ranking in one subject and that in another. Then we say that $r = 0$. It is usual to interpret values of r as follows:—

$r =$ 0.00 to ± 0.20 shows indifferent or negligible relation.
$r = \pm$ 0.20 to ± 0.40 shows low correlation, very slight.
$r = \pm$ 0.40 to ± 0.70 shows substantial or marked relationship.
$r = \pm$ 0.70 to ± 1.00 shows high correlation.

Methods of calculating Correlation coefficients:

1. *The Rank Order Method by Spearman*: See below, the steps for the calculation of the correlation coefficient by this method:

(*a*) Find the ranking of each child in the two subjects.
(*b*) Find the difference in the ranks for each child $= d$.
(*c*) Square the difference to get d^2.
(*d*) Find the total of the column d^2, *i.e.* $\Sigma\, d^2$.
(*e*) Calculate the coefficient of correlation ρ (rho) from the formula $\rho = 1 - \dfrac{6\, \Sigma\, d^2}{N\,(N^2 - 1)}$ where N is the number of cases.

'ρ' calculated by this method gives only an approximate value for the coefficient of correlation. The symbol '*r*' is used only for the accurate value.

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Example for the calculation of ' ρ '

Children	English Marks	Maths Marks	English Rank	Maths Rank	d	d²
A	54	78	12.5	8.0	4.5	20.25
B	94	82	1.0	5.0	4.0	16.00
C	62	49	9.0	16.0	7.0	49.00
D	79	85	4.0	3.0	1.0	1.00
E	56	96	12.5	1.0	11.5	132.30
F	82	52	2.5	14.5	12.0	144.00
G	70	60	7.0	11.0	4.0	16.00
H	49	76	15.0	9.5	5.5	30.25
I	64	82	8.0	5.0	3.0	9.00
J	58	52	11.0	14.5	3.5	12.25
K	59	91	10.0	2.0	8.0	64.00
L	78	58	5.0	12.5	7.5	56.25
M	72	82	6.0	5.0	1.0	1.00
N	82	79	2.5	7.0	4.5	20.25
O	51	58	14.0	12.5	1.5	2.25
P	47	76	16.0	9.5	6.5	42.25
						616.05

$N = 16$ $N^2 = 256$ $\Sigma\, d^2 = 616.05$

$$\rho = 1 - \frac{6 \times 616.05}{16\ (256-1)} = 1 - 0.906 = .094$$

The result shows that there is negligible relation between the two ranks.

It might be noticed that in the example worked out above, in some instances there are ties—i.e., when the same score occurs more than once. The calculation of ranks in that case is as follows:—

Examples:

1. Children *F* & *N* in the worked example above, both have 82 marks each in English, which is the second highest mark in the class. If the children had differing marks, they would have stood 2nd and 3rd respectively. So their actual ranking in this case is calculated by adding up 2 and 3 and dividing it by 2. This gives us 2.5, and this is the rank of either of the two children.

2. *B, I* and *M* have 82 marks each in Mathematics and this is the 4th highest mark. The three children would have occupied the ranks 4, 5 and 6 if they had obtained slightly different marks. Their actual ranking is given by: $\frac{4+5+6}{3} = 5.0$.

11. *The Product Moment Coefficient of Correlation*

This method gives a very accurate value for '*r*'.

A. Find the mean for each subject.

B. Calculate the deviation from the mean for each child in each subject (x for English and y for Maths).

C. Find the product of the two deviations ($x \times y$).

D. Square each deviation, i.e find x^2 and y^2.

E. Find '*r*' using formula.

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \times \Sigma y^2}}$$

Note: When the short method is used, with an assumed mean, a slight modification of the above formula is used. It is:

$$r = \frac{\Sigma xy - Ne_1e_2}{\sqrt{(\Sigma x^2 - Ne^2_1)(\Sigma y^2 - Ne^2_2)}}$$

where e_1 and e_2 are the differences between the assumed means and the real mean for either of the sets of scores.

EXAMPLE:

Children	*English*	*x*	*Maths*	*y*	*xy*	x^2	y^2
A	56	10.2	76	3.7	37.74	104.00	13.69
B	94	27.8	96	23.7	658.86	772.80	561.70
C	62	4.2	82	9.7	40.74	17.64	94.09
D	79	12.8	91	18.7	239.36	163.80	349.70
E	56	10.2	58	14.3	145.86	104.00	204.50
F	82	15.8	85	12.7	200.66	249.60	161.30
G	70	3.8	79	6.7	25.46	14.44	44.89
H	49	17.2	78	5.7	98.04	295.80	32.49
I	64	2.2	82	9.7	21.34	4.84	94.09
J	58	8.2	58	14.3	117.26	67.24	204.50
K	59	7.2	60	12.3	88.56	51.84	151.30
L	78	11.8	76	3.7	43.66	139.20	13.69
M	72	5.8	82	9.7	56.26	33.64	94.09
N	82	15.8	52	20.3	320.74	249.60	412.10
O	51	15.2	52	20.3	308.56	231.00	412.10
P	47	19.2	49	23.3	447.36	368.60	542.90
Total	1059		1156		2850.46	2868.04	3387.13
Mean	66.2		72.3				

$$r = \frac{2850.46}{\sqrt{2868.04 \times 3383.06}} = .907$$

This high value for 'r' shows that the ranks in the two subjects bear a very positive relation to each other.

THE χ^2 TEST—(Chi Square Test)

The results of a particular experiment, if compared with the theoretical values which ought to be present if the quantities belonged to a normal distribution, would give us an idea of the extent of the divergence between the two sets of results. Such a method of comparison is the χ^2 test.

The formula used in this test is: $\chi^2 = \Sigma\left(\frac{(F_o - F_e)^2}{F_e}\right)$

where F is the actual frequencies observed (Observed scores) and F the Expected frequencies (theoretical values if the results were to conform to a normal distribution).

Example: Two groups of subjects were given the same material to learn under differing conditions. Their retention measured by the number of words correctly and incorrectly reproduced respectively was:

	Correct	*Incorrect*
Condition I	1038	531
Condition II	739	798

Procedure:

The scores shown above are the pooled scores of all subjects under the two conditions. The first thing to be done is to calculate the expected frequency. The following chart shows the Observed Frenquency and the expected frequency corresponding to each item.

	Correct		*Incorrect*		*Row totals*
	F_o	F_e	F_o	F_e	
Condition I	1038	897.6	531	671.4	1569
Condition II	739	879.4	798	657.6	1537
Col. Totals	1777		1329		3106

Steps:

A. At first, the totals of each column and row, are found out and written down as shown above. The number 3106 is the grand total of all items.

B. The expected frequency F_e is given in separate columns. It is calculated as follows:

$$F_e = \frac{\textit{Column total under the particular item X Its row total}}{\textit{The grand total of all items.}}$$

The F for 1038 is $\dfrac{1777 \text{ x } 1569}{3106} = 897.6$

The F_e for 739 is $\dfrac{1777 \text{ x } 1537}{3106} = 879.4$

The F_e for 531 is $\dfrac{1329 \text{ x } 1569}{3106} = 671.4$

The F^{e} for 798 is $\dfrac{1329 \text{ x } 1537}{3106} = 657.6$

C. Find the difference between each observed frequency and its expected frequency. Disregard the signs (+or—).

$$\begin{aligned} 1038 - 897.6 &= 140.4 \\ 879.4 - 739 &= 140.4 \\ 671.4 - 531 &= 140.4 \\ 798 - 657.6 &= 140.4 \end{aligned}$$

D. Calculate the χ^2. First square each difference, found out under *C* above. Divide each by its Expected Frequency. Add together all the results. This sum is χ^2.

$$\begin{aligned} \chi^2 &= \frac{(140.4)^2}{897.6} + \frac{(140.4)^2}{879.4} + \frac{(140.4)^2}{671.4} + \frac{(140.4)^2}{657.6} \\ &= 103.68 \end{aligned}$$

E. The degree of freedom is calculated by using the formula $(p-1)(q-1)$, where p is the number of columns and q the number of rows. (Here d.f: is 1).

F. Refer to the χ^2 tables. For d.f. = 1, the significance value at $P = 0.001$ is 10.83. The experimental value is nearly ten times as great. So the result is highly significant. The conclusion to be drawn is that the two conditions differ in a marked manner.

METHOD II FOR THE χ^2 TEST

In a four-fold (2 x 2) table as that given in the example worked out above, the χ^2 may be found out without first calculating the expected frequencies by using the formula:—

$$\chi^2 = \frac{N\ (AD-BC)^2}{(A+B)\ (C+D)\ (A+C)\ (B+D)}$$

where A, B, C, and D are the four items in the geographical positions represented in the tabloid below, and N is the total of all the frequencies. (Fig. 27).

A	B
C	D

FIG. 27

$$\chi^2 = \frac{3106 \text{ x } [(1038 \text{ x } 798) - (531 \text{ x } 739)]^2}{1777 \text{ x } 1329 \text{ x } 1537 \text{ x } 1569} = 103.6$$

When the frequencies (scores in the table) are quite small,—*i.e.* less than 5—a correction called Yates' Correction is applied. Incorporating this correction, the formula reads:—

$$\chi^2 = \frac{N \left(| AD - BC | - \frac{N}{2} \right)^2}{(A + B)\ (C + D)\ (A + C)\ (B + D)}$$

The vertical lines | | enclosing $AD - BC$ mean that the difference between AD and BC, is to be treated as positive irrespective of the sign.

SIGNIFICANCE: Do the results of an experiment really show that some variable has been definitely responsible or are the differences merely due to chance? We can establish this by performing statistical tests which would show whether the results are significant or not. In statistics the word 'significance' has a meaning different from that in ordinary usage. It does not, for instance, mean 'importance'. Results are 'significant' if and when it can be proved that they are not due merely to chance. There are different levels of significance. We can say, for instance, that the chances are 5 in 100 that the results may be due to mere accident (chance). Or we can say that the odds are 100 to 1 that these may be due to chance and so on. These probabilities, odds, or chances are represented by the letter '*P*' (Probability). Probability itself is expressed as a decimal. For instance, when we say that the level of significance is $P = .05$, it means that the chances are 5 in 100 that the results are due to mere accident. When $P = .005$, the probability is that it is 5 in 1000 that the results are due to chance. Usually in Psychology, we consider values of P between .05 and .001 as significant. If the level of significance is $P < .001$ (less than .001), so much the better.

Tables have been worked out, showing the values for significance at various levels. These values depend also on the degree of freedom (*i.e.* it depends on the number of subjects used or the number of frequencies and so on).

The 't' Test

This test is very often used for the comparison of the performances of a group of subjects under two different conditions.

Example: The scores of 12 subjects in a reading performance test under normal conditions and after consuming a specified quantity of alcohol, are given below. It is required to test whether the scores under the two conditions are significantly different.

Sl. No.	*Scores before Alcohol*	*Scores after Alcohol*	*Difference* x	x^2
1.	12	8	4	16
2.	11	9	2	4
3	14	7	7	49
4.	13	10	3	9
5.	12	12	0	0
6.	12	13	—1	1
7.	13	9	4	16
8.	12	8	4	16
9.	15	8	7	49
10.	14	7	7	49
11.	13	8	5	25
12.	14	9	4	16
		Total	46	250

$\Sigma\, x = 46$

$\bar{x} = 3.83$ (Arithmetical mean of $\Sigma\, x$)

$\Sigma\, x^2 = 250$

$$\text{Variance} = (\text{S.D.})^2 = \frac{\Sigma\, x^2}{n} = (\bar{x})^2$$

$$(\text{S.D.})^2 = \frac{250}{12} = \binom{46}{12}^2$$

$$= 6.13$$

$$\text{S.D.} = \surd 6.13 = 2.48$$

$$\text{S.E.} = \frac{2.48}{\surd 11} = \frac{2.48}{3.32}$$

$$\text{t} = \frac{3.83 \text{ x } 3.32}{2.48} = 5.13$$

A reference to the tables shows that at the .001 level of P, the value for $t = 4.32$ at 12 degrees of freedom. Our value of 5.13 exceeds this and so the results are significant at the .001 level for P. Interpreting this high level of significance of the difference between the two sets of results, we conclude that the performance after drinking alcohol, is definitely inferior to that in the sober condition.

A Summing-Up

In assessing the present status of Psychology, one has to take into account several factors, the development of methods of experimentation, the present trends in theorization, and above all the degree of acceptance which other disciplines have accorded to it. Ever since it broke fresh ground in its own right and moved away from formal philosophy, its terminology and definitions have undergone successive modifications consonant with experimental findings. The definition of psychology itself has changed its subjective connotations to one more befitting its scientific status. Not so very long ago, when the method of introspection was dominant in experimentation, psychology was described as the science of the mind. Later, when reaction set in against the mentalistic concepts of early psychological discipline, this definition underwent a transformation in order to accommodate the objectivity which claimed importance in the neo-psychological doctrines. Today it may well be said that Psychology has progressed beyond the half-way mark on the road to its establishment as an experimental science.

The current emphasis on behaviourism is not just a reaction by left-wing influences against the introspection-ridden early psychology, but is more of an attempt to keep in step with contemporary theories—those of the biological sciences in particular. The theory of evolution has greatly influenced methods of experimentation especially with the recognition of the complex nature of human behaviour and therefore of the need to find simpler behavioural systems which could be experimented upon. When it was realized that all organisms, from the simplest to the most complex belonged to a phylogenetic continuum, and that differences are those of degree and not necessarily of kind, experimentation on animals received a new fillip. Lashley's experiments on the behavioural modifications of rats consequent on progressive ablation of the brain, led to the theory of equipotentiality of the cerebrum; other experimenters using organisms higher up in the phylogeny, established the fact that behavioural differences between species are due to the gradual increase in encephalization with ascending levels of phylogeny.

Behaviourism itself has had a chequered career; contemporary concepts of its implications are a far-cry from J. B. Watson's mechanistic principles which denied the existence of everything that could not be directly observed. Behaviourism today is much more eclectic in that certain unobservable intervening variables also have been admitted as valid psychological bases for theorizing and experimentation.

Learning, perception and memory continue to be the central problems in psychology, the last two, in point of fact, being parts of the total process of learning. Recent writers on psychological problems—like Hebb, for instance—logically contend that the bases of adult perception are not wholly innate but may have to be learned by a prolonged, possibly unwitting, process of training. Evidence has been quoted not only from the performances of primates reared in complete darkness but also from the initial experiences of congenitally blind people restored to normal vision after an operation.

Out of the medley of stimuli in our environment, we perceive only a few. Thus selective perception raises another problem: do we perceive much more than what we are aware of? It has been claimed that under hypnosis and by the administration of some kinds of drugs, long-forgotten memories, and also the memory of things that a person was not conscious of having perceived, can be revived.

Having perceived, the next difficulty is concerned with how the percept is stored in the organism. If memory consists of permanent structural modification of specific parts of the central nervous system, it is hard to see how perceptual generalization can take place. On the other hand, if a field theory, like the one envisaged by Gestalt psychologists, is accepted, then it is difficult to explain how lasting memorial traces could be established. When the stimulus material is presented for a very brief duration, retention declines rapidly; repeated presentations make learning more permanent. Thus there must be some way by which the effects of learning can accumulate. And the retained effects of learning do not correspond exactly to the stimulus material, as is shown by the distortions evident in reproductions after an interval. If this is to be explained, the locus of such distortions becomes important. Theoreticians, who believe that changes occur concurrently with perception, postulate a theory of schema under which it is obvious that no new percept can get absorbed into the schema without itself undergoing changes and at the same time changing the schema. The Gestalt psychologists, on the other hand, think that memorial traces may undergo spontaneous changes during the retention interval and thus cause the distortions. Some others think that changes take place at the time of recall due to competition between the correct items and other extraneous elements.

To complicate matters still further, attitudes and interests affect retention in quite remarkable ways. Motivated remembering and forgetting have almost been made into hedonistic principles by Freudian psychology which formulates a dynamic theory of forgetting due to active repression. Repressed memories are not lost, but disappear into the unconscious whence they exert a definite influence on behaviour. Thus the unconscious control of conscious behaviour is the central idea in (what is known as) 'depth psychology'. Jung went a step further and formulated in addition a Collective Unconscious consisting mainly of racial memories. Thus a newborn infant may be thought of as starting life with a rich heritage in the unconscious.

Just as certain bases of perceptual ability are innate, there are some other behaviour systems which become quite serviceable, the first time they occur. In the young baby, the sucking movements of the lips, fear reactions at a loud noise and its smile, are some examples of innate reactions. In the primates, at least, it is not easy to distinguish instinctive behaviour from acquired patterns because learning processes continue all through the waking life of these individuals. The problem of intelligence also is involved in this controversy because an unqualified acceptance of either the doctrine of innateness of intelligence or of its modifiability would mean a radical reassessment of our thinking and perhaps of our educational systems as well.

Mathematical models in psychological theorising are very much in vogue today but these have had a mixed reception partly because of the belief in some quarters that psychology is not quite ready for precise quantification. The Information Theory modelled on familiar communication systems, has been of great help in enabling a better understanding of the possible mechanisms involved in learning and memory.

At present, psychology has received wide acceptance as an experimental discipline. Its methods are those of the physical sciences and statistical devices have been evolved to ensure that conclusions are not indiscriminately drawn from experimental results. Introspection is sometimes used as an adjunct to objective experimentation, but it is no longer the basic tool in experimental psychology.

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ERRATA

Page 6, line 11, *for* Wermicke *read* Wernicke
38, line 33, *for* are allowed *read* is allowed
49, Fig. 10, *for* Schroder *read* Schröder
51, line 13, *for* road *read* rod
60, line 10, *for* only is the *read* only are the
67, line 8, *for* to familiar *read* to two familiar
75, line 9, *for* Miller *read* Müller
82, line 10, *for* Naage *read* Nagge
84, line 9, *for* corect *read* correct
109, line 33, *for* Weigal *read* Weigl
153, line 21, *for* distracing *read* distracting
159, line 3, *for* John Hopkins *read* Johns Hopkins
159, line 15, *for* cannon *read* canon
175, Fig. 26, *for* Budhists *read* Buddhists
188, line 16, *for* that county *read* every county
196, line 17, *for* the F for *read* the F_e for

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